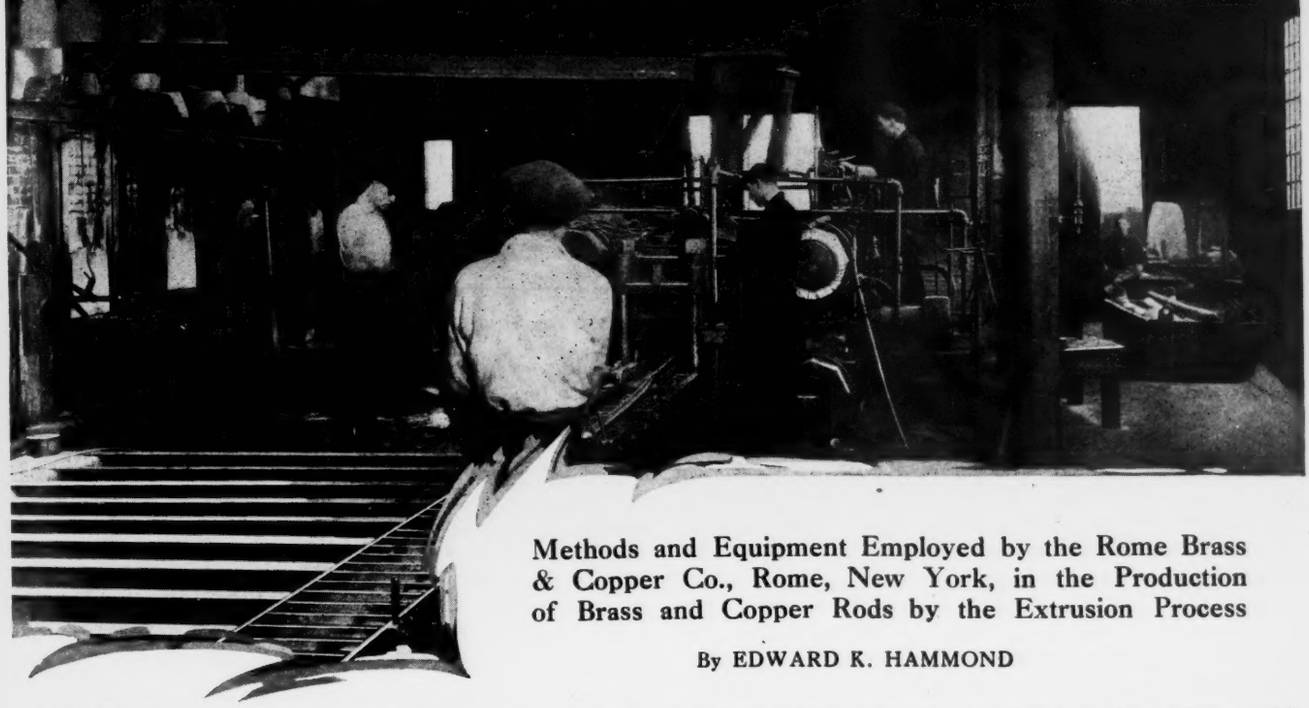
Extruding Brass and Copper Rods



Methods and Equipment Employed by the Rome Brass & Copper Co., Rome, New York, in the Production of Brass and Copper Rods by the Extrusion Process

By EDWARD K. HAMMOND

A MARKED economy is effected by using the extrusion process in the production of brass and copper rods. By this method, a billet can be converted by a single operation into a rod of practically the required size. After the extrusion has been accomplished, it is only necessary to pickle the work to remove oxide scale, give it one pass through the die on a draw-bench to reduce the diameter to the required size, and finally straighten the rod and cut it into pieces of the desired length. Those who are familiar with older methods of manufacturing brass and copper rods will readily appreciate the importance of substituting an extrusion process, which can be performed in a few seconds, for a sequence of drawing operations that would otherwise be necessary, and that would involve repeatedly annealing the metal to reduce hardness and physical strains.

Preparing the Metal for Extrusion

At the plant of the Rome Brass & Copper Co., in Rome, N. Y., where data were obtained to form the basis of this article, it is the practice to extrude cast billets measuring 26 inches in length by 6¾ to 7 inches in diameter. The metal is melted in crucible furnaces which are fired with coal and equipped with natural draft, the molten metal being cast in cylindrical shaped molds. In producing brass billets for subsequent extrusion into rods, various mixtures are employed to meet the requirements of different consignees; and it is necessary for the casting shop to compound copper and zinc, or copper, zinc, and tin in the required proportions to fulfill these different specifications. The billets are cast in vertical molds and the next step is to cut off the excess metal from the upper end, for the double purpose of reducing the billet to the specified length of 26 inches and to remove metal which may be of inferior quality. After cutting off the crop end, the cross-section of the metal is inspected to be sure that it is solid and free from such defects as pipes, blow-holes, etc. The billet dimensions which have been given provide the volume of metal which is ordinarily used for extrusion; but where especially long rods are ordered or where other special conditions arise, it may be necessary to make special sized billets to meet the requirements of the job.

Heating the Billets Ready for Extrusion

The extrusion process is performed with the metal at a temperature of from 1600 to 1700 degrees F., that is to say within about 200 degrees F. of the melting point, so that the metal is in a condition to flow freely when the pressure is applied. For heating the billets a special furnace is employed, which has an inclined hearth down which the billets roll by gravity. A continuous procession of billets is passing through the furnace, about one hour being required for a billet to roll from the door at one end of the furnace through which it enters, to the door at the opposite end from which the heated billet is removed. This allows sufficient time for the heat to thoroughly soak into the metal, so that its temperature is uniform throughout, and as a result there is no danger of lack of uniformity in the ductility or other physical properties. At the right-hand side of Figs. 1 and 2 the billets will be seen entering the furnace at *A*, it being merely necessary to raise the end door to allow the billets to roll down the hearth until they come against a continuous row of billets inside the furnace. For transferring the heated billets to the extrusion press, use is made of a lever shown at *B* in Fig. 2, which is furnished with two bent arms that are shaped to hold a billet as it is rolled off the hearth of the furnace. This lever is suspended from a trolley *C* so that relatively little physical effort is required of the furnace attendant to carry a billet across and deposit it in a pivoted transfer arm *D*, Fig. 3, on the extrusion press.

Design and Functions of the Press

The extrusion presses used by the Rome Brass & Copper Co. for making rods were built by the Watson-Stillman Co. of New York. Each press completes the extrusion process at a single operation. Fundamentally each machine consists of

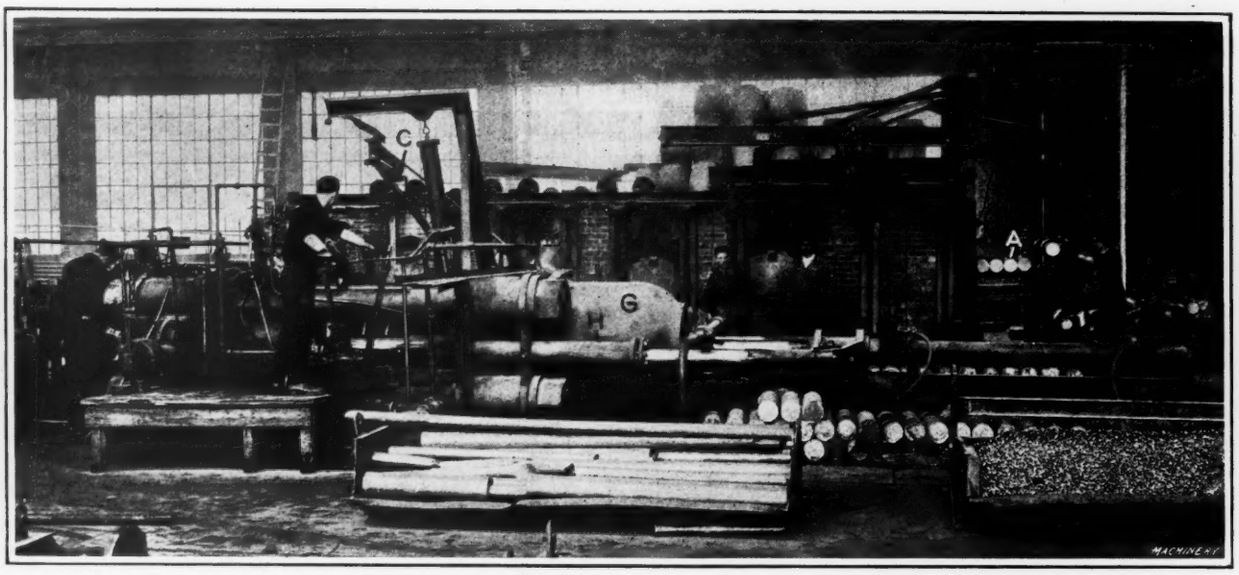


Fig. 1. General View of the Hydraulic Extrusion Press and Furnace in which the Billets are heated

a cylinder known as a "container," at the forward end of which there is a die of similar design to the die on a draw-bench, and at the back end there is a plunger or piston which applies pressure at the back of the heated billet after it has been placed in the container. Through the application of hydraulic pressure, the plunger moves forward and causes the heated metal to flow out through the die at the forward end of the container, a billet measuring 26 by 6¾ inches being converted into a long thin rod by this method. There is considerable variation in the size of rods that can be produced by the extrusion process, the range at this company's plant extending from ⅜ inch to 4 inches in diameter. A billet of standard size would produce a ⅜-inch rod 703 feet long, as well as a 4-inch rod 6 feet long.

Sequence of Movements in Operating the Extrusion Press

Having made a general statement of the way in which the extrusion press accomplishes its work, we are in a position to enter into a detailed description of its construction and the sequence of movements that are involved in operating an equipment of this type. When the heated brass or copper billet is carried from the furnace and deposited in the transfer arm *D*, Fig. 3, the oscillation of this arm rocks the billet over into line with the container of the extrusion press. Then an auxiliary pusher-rod which runs through the center of the main ram, moves forward into contact with the end of the billet and pushes it into the container. This rod is operated by a compressed air cylinder shown at *F* in Fig. 2. The billet is pushed in far enough so that there is sufficient space to insert a steel disk known as a "dummy block" behind it, after which the main ram of the press advances and pushes both the dummy block and the metal forward, the action being similar to that of a piston compressing air or gas in a cylinder; but as the heated brass or copper is non-compressible, the only way in which it can adapt itself to the constantly contracting volume of space between the dummy block and the front end of the container, is for the metal to flow out through the extrusion die. Presses of this type are built for operation at pressures up to 5000 pounds per square inch, giving the main ram pressure capacity up to 2000 tons.

Materials Used for Making the Extrusion Dies and Container Lining

The extrusion die is made of high-speed steel, and there may be two or more openings in the die so that more than one extruded rod emerges from the press simultaneously. This practice is followed in the case of rods of small diameter in order to reduce the length of the rods. For instance, it has been stated that a billet of standard size contains sufficient metal to produce a ⅜-inch rod 703 feet long, but the die used for such a size would have at least four openings, thus reducing the length of each rod to about 175 feet. Each rod is gripped in a pair of tongs carried by a laborer whose duty it is to draw the work along a roller hot bed to avoid danger of its buckling. It will be apparent that the action of hot metal under the high pressure that is used in

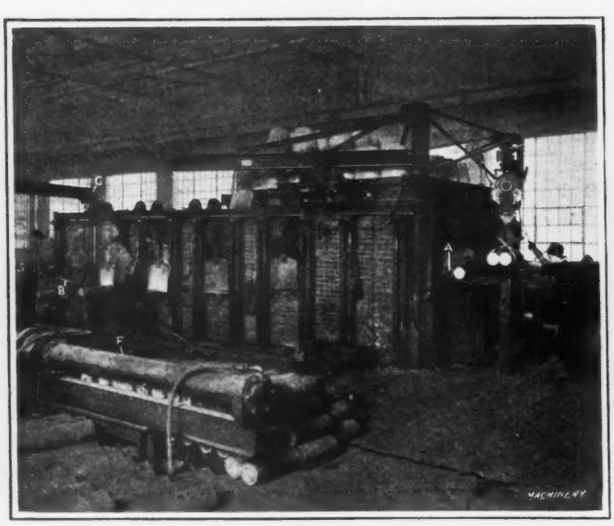


Fig. 2. Close-up View of Heating Furnace, Billet-carrying Trolley and Air Cylinder for operating the Auxiliary Pusher-rod

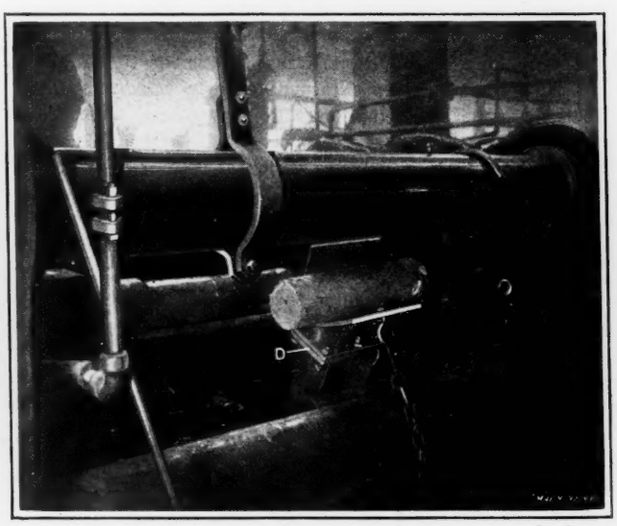


Fig. 3. Close-up View of Rocker Arm which transfers a Heated Billet into the Required Position for entering the Container

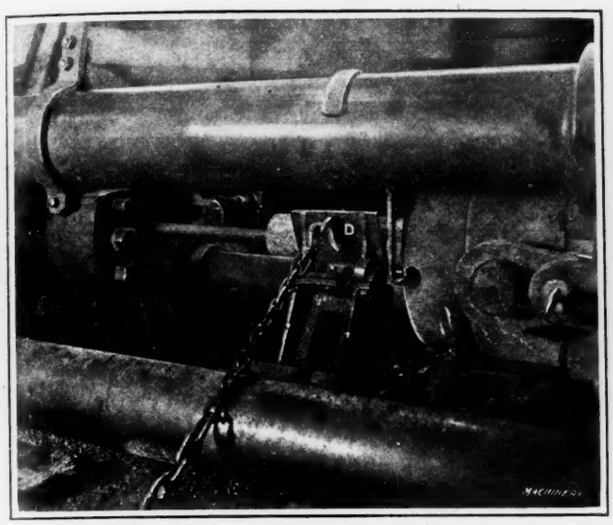


Fig. 4. Rocker Arm D has swung over, and the Pusher-rod is sliding the Billet into the Container

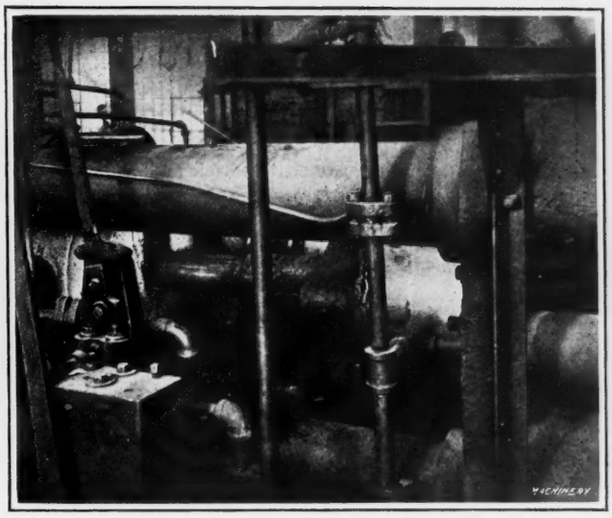


Fig. 5. Close-up View of Main Ram advancing into the Container to perform the Extruding Operation

extrusion must exert considerable wear and tear on the container and dies of the extrusion press. The dies are of simple construction and relatively inexpensive, so that their replacement is not a serious item. But it would not do to have the container so constructed that it had to be entirely replaced when the inner surface became worn. To avoid such a serious item of expense, the expedient adopted is to insert a steel lining in the container. This practice is quite similar to that followed in the construction of large field and naval guns, with which most engineers have become more or less familiar, due to the publicity that this subject has received during recent years.

In starting to operate an extrusion press, it is necessary to preheat the inside of the container sufficiently so that it will not tend to chill the billet before the extrusion operation can be completed. This preheating is accomplished by successively pushing several red-hot billets into the container and allowing them to remain until most of their heat has been absorbed, after which the billets are withdrawn. There is no way of telling definitely what temperature is reached by the inside of the container, but it is estimated that this approaches a red heat after the press has been in continuous operation for several hours. Mention was made of the use of a dummy block between the end of the billet to be extruded and the main ram of the extrusion press. The function of this dummy block is to prevent the red-hot metal from coming into contact with the ram, which would result in the destruction of the ram and cause a serious expense when replacement became necessary. The dummy block is of negligible cost so that its destruction is a matter of very slight importance.

Removing the Butt End of the Billet from the Container

A little thought will make it apparent that it would be impossible to extrude all of the metal out through the dies, and as a residue is left in the container and attached to the rods extending through the die, some means must be provided for cutting off this butt end of the billet and removing it from the container. This result is accomplished by having the forward end of the container which carries the extrusion die mounted on a slide, so that the die may be securely held in place at the end of the container while extruding the metal, after which the slide and forward end of the container may move forward to bring the butt end of the billet under a shear blade which cuts it off. Then the extruded rods can be pulled out of the die, after which the slide returns to its initial position ready for performing the next operation. The arrangement of this slide for carrying the front end of the container and the provision made for shearing off the butt end of the billet will be readily understood by referring to Figs. 6 and 7. The shear blade is shown at *I*, the extrusion die at *J*, and the dummy block that enters the container behind the billet is illustrated at *K*.

After the extrusion die has been cleared by shearing off the butt end of the billet, the plunger is returned to the starting point by means of pull-back cylinders located at either side of the main cylinder *G*, Fig. 1. One of these pull-back cylinders is shown at *H* in the same illustration.

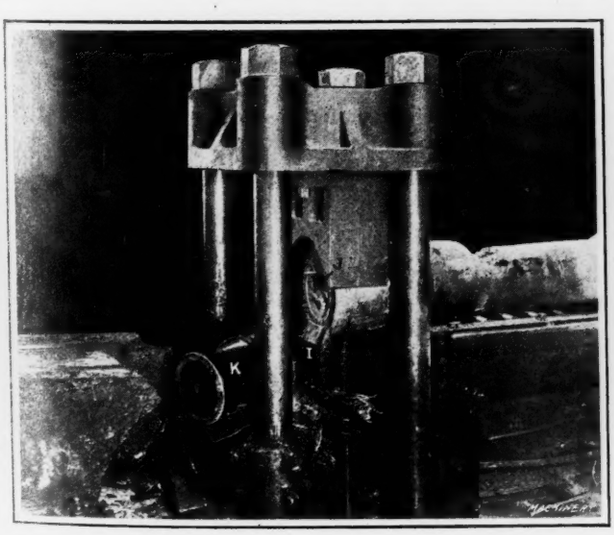


Fig. 6. Shear Blade I has cut off the Butt End of the Billet so that the Extruded Rod can be withdrawn from Die J

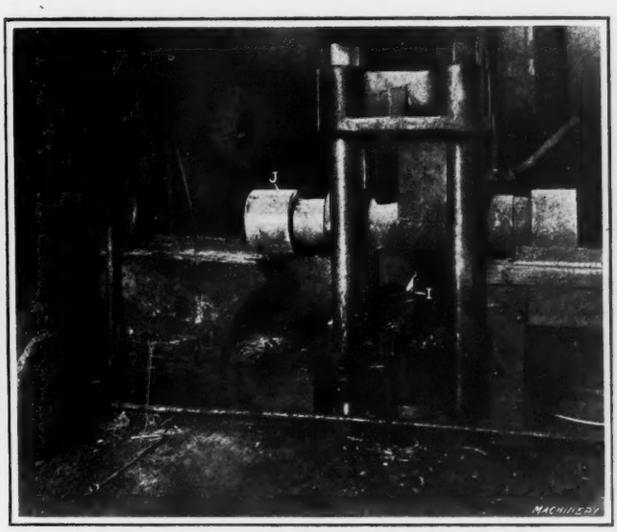


Fig. 7. Here the Slide is shown returning Die J to its Position in the Forward End of the Metal Container

All movements of the rams are governed by a set of specially designed operating levers controlled by pilot valves located at the side of the machine.

Pickling, Drawing, and Straightening

After the extrusion process has been completed, it is still necessary to remove the oxide scale which has formed on the red-hot metal as it emerges from the die, subject the work to a cold-drawing operation which improves the smoothness of the surface and reduces the rod to exactly the required diameter, and finally straighten the bar ready for shipment to the consignee. Pickling is accomplished by immersing the rods in a tank containing a solution of "Edis" compound, the strength of which is such that the solution has a specific gravity of 30 degrees Baumé. A 5 per cent solution of sulphuric acid could be used with satisfactory results. It is necessary to pickle the rods both with the view of removing the scale to improve the appearance of the product and to avoid damage to the cold-drawing dies which would result from having this hard surface coating on the metal. The drawing is accomplished in a hydraulic draw-bench built by the Waterbury Farrel Foundry & Machine Co., of Waterbury, Conn., and after drawing, the rods go to a straightening machine of the type built by the Medart Patent Pulley Co., of St. Louis, Mo. Both of these equipments have been described in MACHINERY in connection with the manufacture of cold-drawn shafting and screw stock, seamless brass and copper tubes, etc. After straightening, the rods are cut up into lengths specified by the consignee and packed for shipment.

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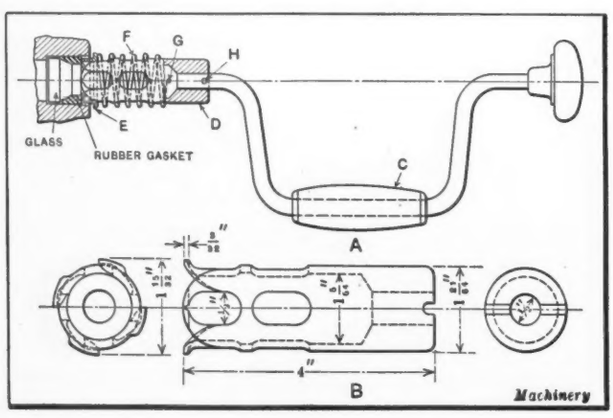
TOOL FOR REMOVING LUBRICATOR GASKETS

By NORMAN McCLEOD

The replacing of the rubber gasket in certain types of sight-feed lubricators is sometimes necessary, but its removal frequently results in badly marring the threads provided for the retaining cap. The consequence is that the hole must often be retapped to a larger diameter and another cap provided. The device shown at *A* in the illustration was designed for the purpose of removing gaskets without impairing the threads. It consists of a carpenter's brace *C* and a hollow circular tool-steel cutter *D*, shown in detail at *B*.

When it is desired to remove a gasket, a special steel bushing *E* and an expansion coil spring *F* made of ⅛-inch wire, are first slipped over the small end of the cutter. The spring is held in place by a pin *G*. The purpose of the bushing is to protect the threads and to guide the cutter when removing the gasket, while the spring exerts a pressure on the bushing and prevents it from withdrawing from the hole. After the cutting end of tool *D* and bushing *E* have been placed in the hole, the end of brace *C* is inserted in the opposite end of the cutter. Then by means of pin *H*, which projects from each side of the brace and engages with a groove in the cutter, the tool can be readily turned.



Tool designed for removing Rubber Gaskets from Sight-feed Lubricators

FORMULA FOR MAKING TAPER MEASUREMENTS

By C. N. PICKWORTH

The formula published in the April number of MACHINERY, page 763, for finding the diameter of a disk to be placed in contact with a disk of different diameter when measuring tapers, involves four distinct operations including the squaring of a five-figure quantity. The writer is in favor of simplifying the method explained in MACHINERY'S HANDBOOK, page 899, which may be written as a formula in the following form, in which the letters *D* and *d* represent disk diameters, and *a* the angle, as shown in the diagram.

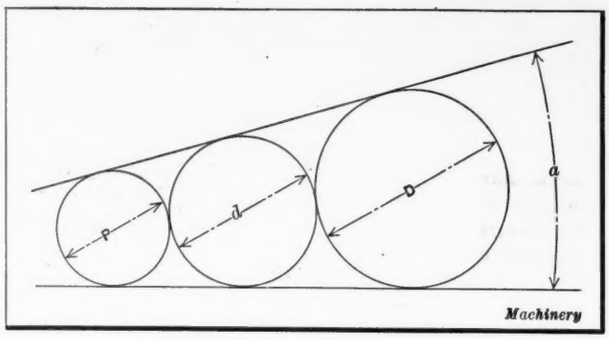


Diagram used in Connection with Taper Measurement Formula

$$D = \frac{2d\left(\sin\frac{a}{2}\right)}{1-\sin\frac{a}{2}} + d$$

From this we get

$$D = \frac{2d\left(\sin\frac{a}{2}\right) + d - d\left(\sin\frac{a}{2}\right)}{1-\sin\frac{a}{2}}$$

$$= \frac{d\left(\sin\frac{a}{2}+1\right)}{1-\sin\frac{a}{2}}$$

or, expressed in conventional form

$$D = d \times \frac{1+\sin\frac{a}{2}}{1-\sin\frac{a}{2}}$$

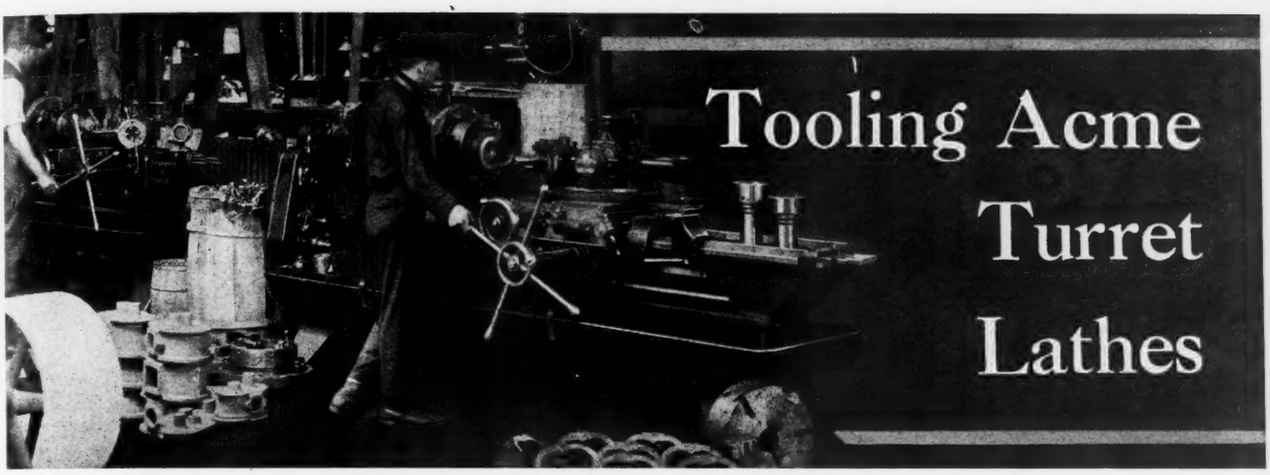
Applying the above equation to the example contained in the previously published article, where *d* equals 1 inch and *a* equals 15 degrees,

$$D = 1 \times \frac{1.13053}{0.86947} = 1.3002 \text{ inches}$$

It may be of interest to point out that the diameter of the tangent circle *P* (see diagram) on the opposite side of circle *d*, is the reciprocal of the diameter *D*, that is

$$P = d \times \frac{1-\sin\frac{a}{2}}{1+\sin\frac{a}{2}} = 1 \times \frac{0.86947}{1.13053} = 0.76908 \text{ inch}$$

From the foregoing it follows that the product of the diameters of the two tangent circles *P* and *D* is constant and is equal to the square of the diameter of circle *d*.



Tooling Acme Turret Lathes

Tooling Equipment for Performing Turret Lathe Operations on Friction Pulleys, Aluminum Pistons, Gear Blanks and Other Machine Parts

IN turret lathe operations increased output is often obtained by a carefully thought out arrangement of the tools that are used and the order in which successive operations are performed. This is a specialized branch of tool designing, and most of the builders of turret lathes maintain engineering service departments which are prepared to design special tool equipments to meet the requirements that must be fulfilled in machining parts handled on their lathes. Acknowledgment is made to the tool designers of the Acme Machine Tool Co., Cincinnati, Ohio, for data and illustrations which form the basis of this article. All the tools have been actually developed for use on Acme machines. So far as possible, examples have been selected which deal with the finishing of pieces of the general types that are handled on turret lathes. The methods of tooling up for these jobs will suggest ways and means for the efficient performance of many similar operations; and statements concerning the rates of production which are secured with this equipment will enable manufacturers in similar lines to compare their rates of output with those which are being attained in other industrial plants.

Turret Lathe Operations on Friction Pulleys

Fig. 1 illustrates the tools provided on an Acme universal turret lathe for performing machining operations on friction pulleys at the plant of the Davis & Furber Machinery Co., of North Andover, Mass. At the first setting of the work, there are two sequences of three operations each to be performed on these pieces. It will be evident that a three-jaw chuck is used to hold the casting by its outside diameter, and tools carried by the main turret are employed for facing hub *A* and rim *B*, for boring hole *C*, and for reaming the same hole with a tool carried on the next face of the turret.

After the boring tool has started its cut in hole *C*, the second sequence of operations is commenced with tools carried by a turret toolpost mounted on the carriage. These tools are shown at the left-hand side of Fig. 1, where it will be apparent that the first tool is employed to turn taper *D*, connection being made with a taper-turning attachment at the rear to obtain the required form for the work. This taper-turning operation proceeds while the boring operation takes place in hole *C*. After indexing the turret toolpost, the tool at the second station turns hub *E*, and when this

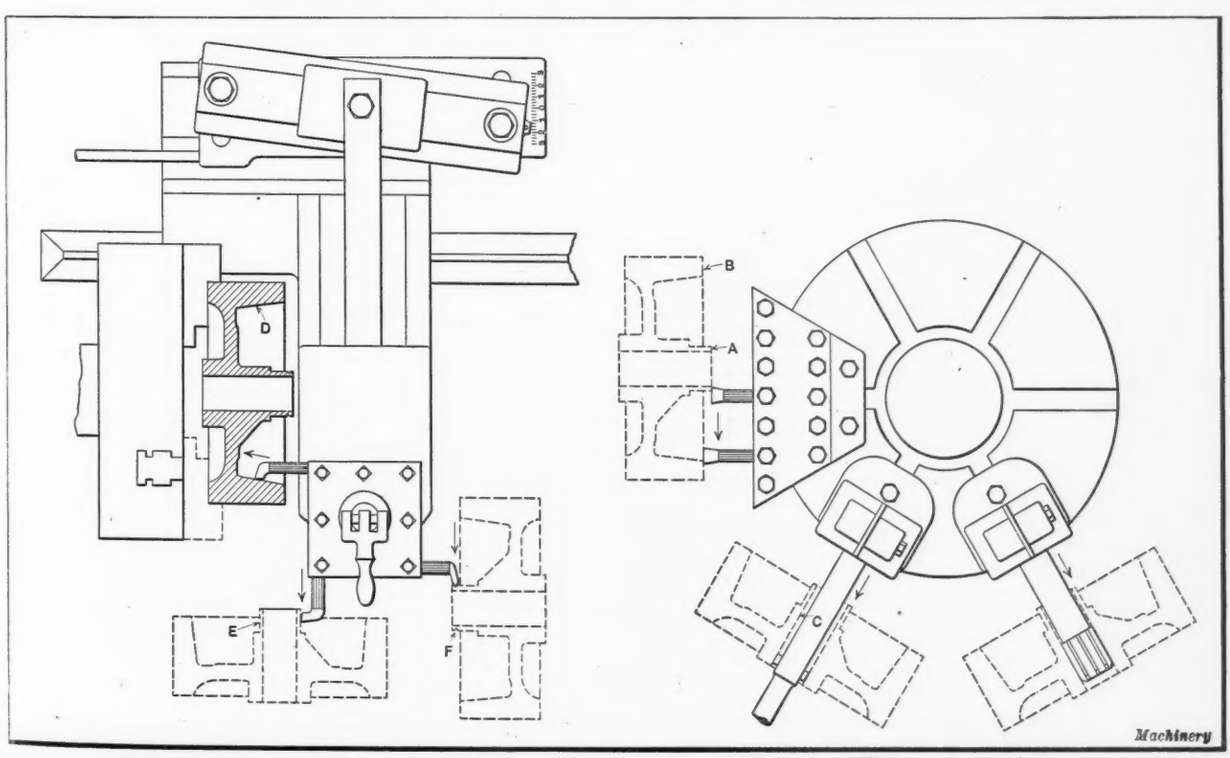


Fig. 1. Diagram of Tool Lay-out for First Sequence of Turret Lathe Operations on Friction Pulleys

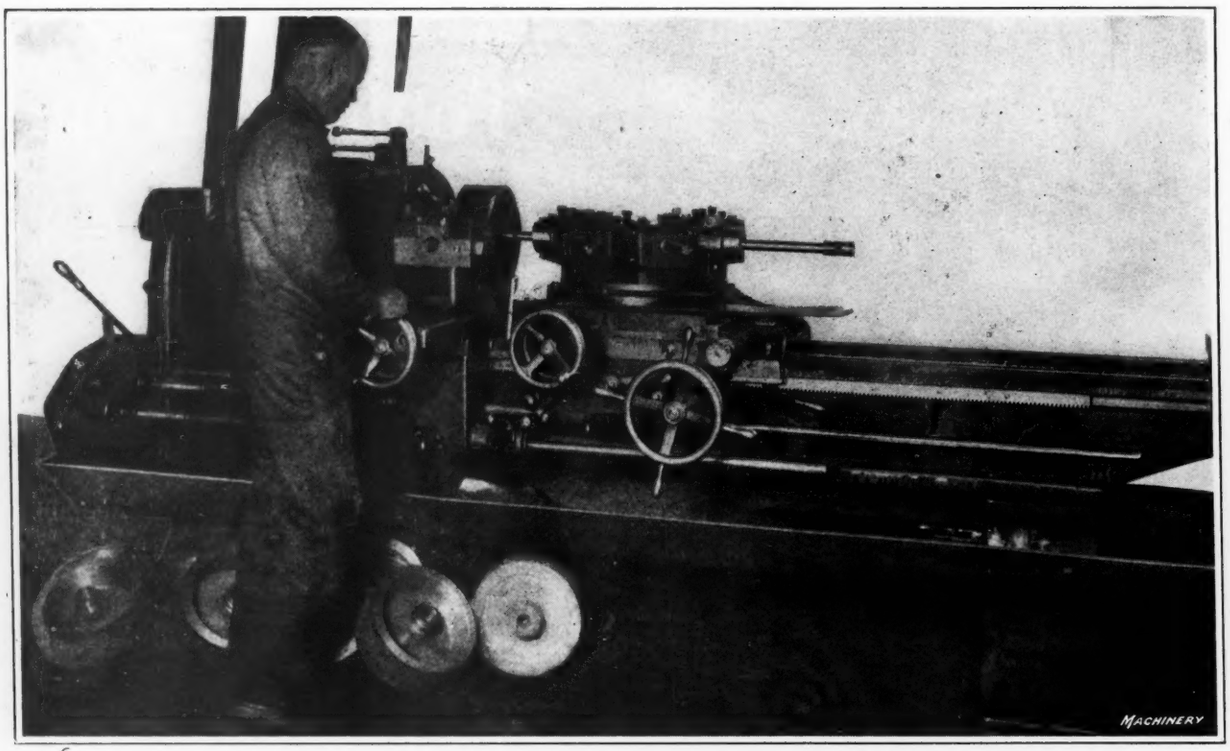


Fig. 2. Turret Lathe equipped for Second Sequence of Operations on Friction Pulleys

result has been accomplished, the turret toolpost is again indexed to bring the third tool into position for turning a notch *F*. Conforming with the usual practice, none of the tools mounted on the carriage are in operation while the reamer in the turret is finishing hole *C*. These friction pulleys are made of cast iron, and with the tool equipment here illustrated and described, it is possible to perform the complete series of operations in 45 minutes.

Second Sequence of Operations on Friction Pulleys

After bringing the friction pulley castings to the condition in which they leave the tools illustrated in Fig. 1, it is still necessary to perform a second sequence of operations on the outside diameter and the opposite end of the castings. The machine set up for this purpose is shown in Fig. 2, and a special work-holding fixture shown at *G* in Fig. 3 is secured to the spindle nose, which provides for utilizing the taper bore *D*, that was finished during the preceding sequence of operations, as a locating point. By following this method, assurance is obtained that the surfaces which still have to be finished will be brought into the proper relationship with those that have already been machined. To assist in maintaining accurate alignment and freedom from spring, there is a pilot *H* mounted on the work-holding fixture, which

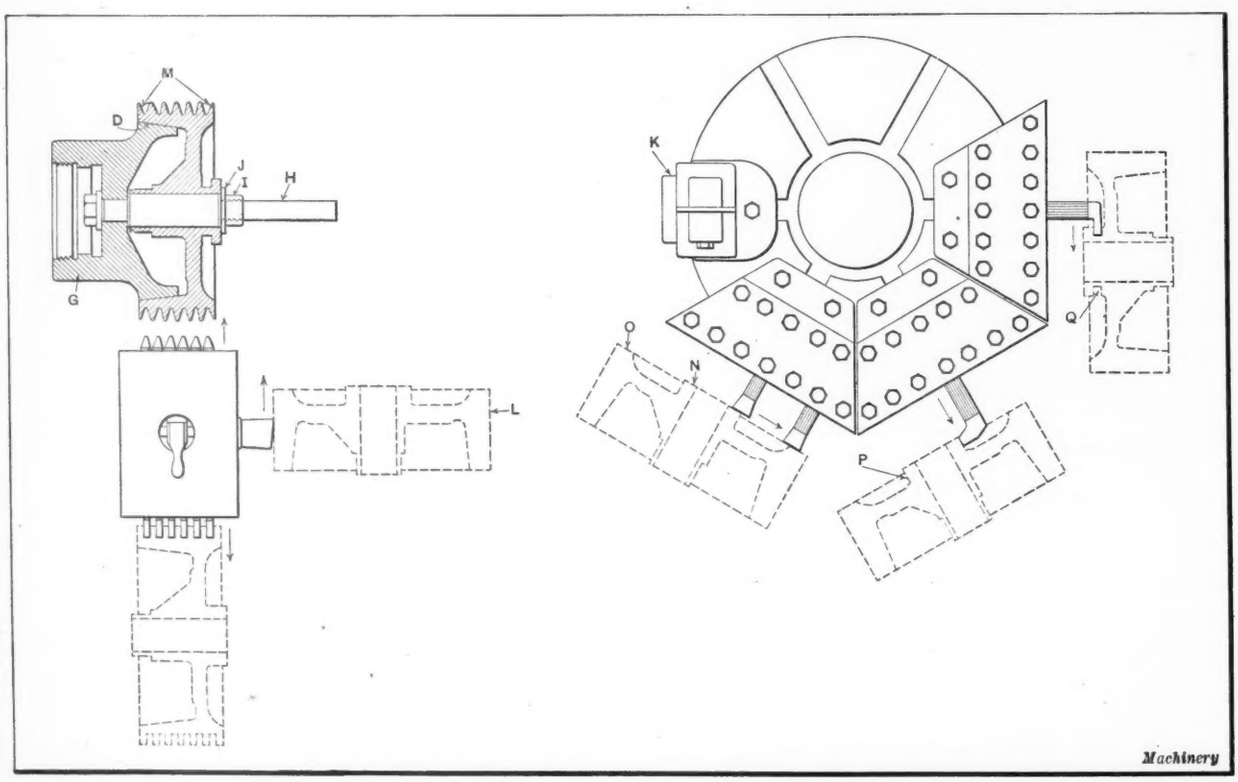


Fig. 3. Diagram of Tool Lay-out for Second Sequence of Turret Lathe Operations on Friction Pulleys

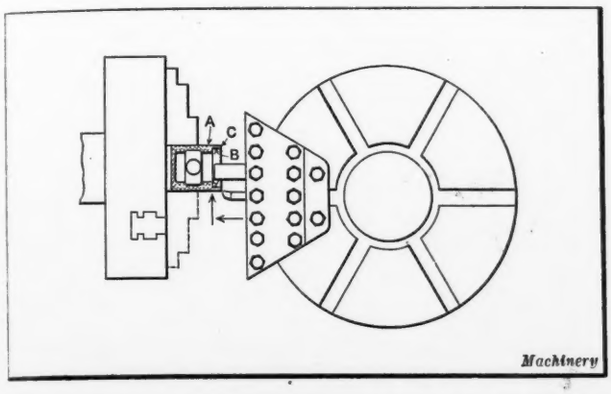


Fig. 4. Lay-out of Tools for First Sequence of Turret Lathe Operations on Pistons

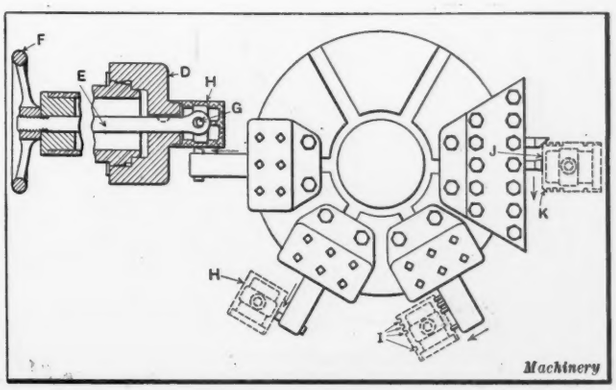


Fig. 5. Lay-out of Tools for Second Sequence of Turret Lathe Operations on Pistons

projects through the finished bore of the work, so that it may enter a bushing on the turret to provide additional support for the work while the multiple grooving tools mounted on the carriage are taking their heavy cut. Attention is called to the nut *I* and washer *J*, by means of which the casting is held back on the taper nose of work-holding fixture *G*. It will be evident that the diameter of nut *I* is small enough to enable it to pass through the bore of the work, and washer *J* is of the familiar slotted type so that it is only necessary to slightly loosen the nut and withdraw the washer, after which the work can be slipped over the nut. This practice is the means of saving a considerable amount of time in setting up castings and removing finished pieces from the fixture.

With the casting held on a work-holding fixture as shown, the turret is advanced to allow pilot *H* to enter bushing *K* carried on the first station of the turret. Mounted on the cross-slide there is a turret toolpost with a turning tool carried by the first face to provide for turning the outside diameter *L* of the pulley. On the second station there are six square-nosed grooving tools which provide for roughing out grooves in the outside of the work, and on the third station a similar set of pointed tools provides for finishing the grooves to the form shown at *M*. The bushing *K* and pilot *H* prevent the work from springing while these heavy cuts are being taken. On the second station of the turret, two facing tools provide for facing surfaces *N* and *O*; on the third station a tool turns the outside diameter *P* of the hub; and at the fourth station a hook tool turns groove *Q* in the hub. In the performance of this sequence of operations, 60 minutes is required to complete the job on one pulley.

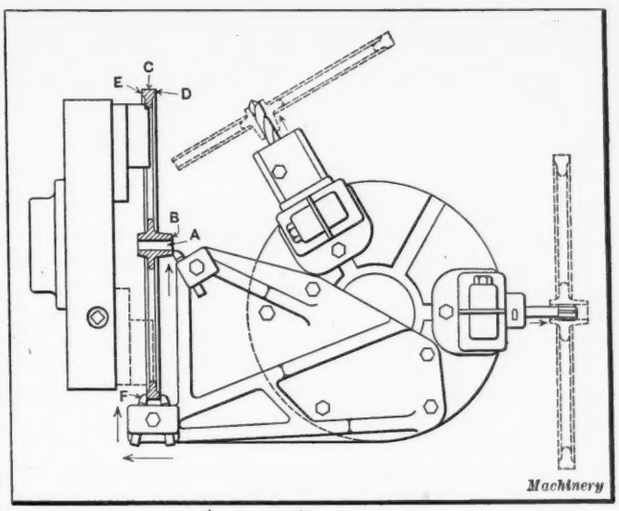


Fig. 6. Lay-out of Tools for drilling, reaming, facing and turning Gear Blanks on a Turret Lathe

Turret Lathe Operations on Aluminum Pistons

Fig. 4 illustrates tooling developed for use in performing the first of two successive series of operations on aluminum pistons at the plant of the Orteig Motor Co., New York City. Reference to this illustration will make it apparent that piston *A* is held by its outside diameter in a three-jaw chuck, and that two tools mounted on the first face of the turret provide for boring out the skirt at *B* and facing end *C* of the piston. For this combination boring and facing operation on piston skirts, the rate of production is fifty-five pistons per hour. These two finished surfaces are then used as locating points for holding the work while a second sequence of operations is being performed.

Second Sequence of Operations on Pistons

In Fig. 5 there is shown a diagram of the tools employed for the second sequence of operations on aluminum pistons. A work-holding fixture *D* is mounted on the spindle nose, the forward end of which is formed to accurately fit into the bored and faced skirt of the piston. Extending through the turret lathe spindle there is a draw-in rod *E*, the left-hand end of which is threaded to receive handwheel *F* that has its hub bored and tapped to fit the screw on the draw-in rod; and at its right-hand end, rod *E* has an eye formed on it to enable pin *G* to be slipped through the wrist-pin hole in the piston and through this

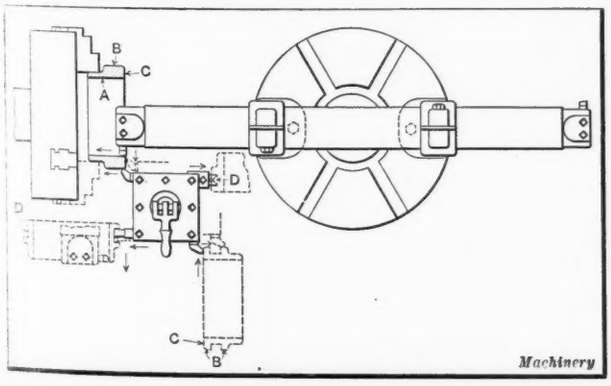


Fig. 7. Diagram of Tool Lay-out for First Sequence of Turret Lathe Operations on Friction Sleeves

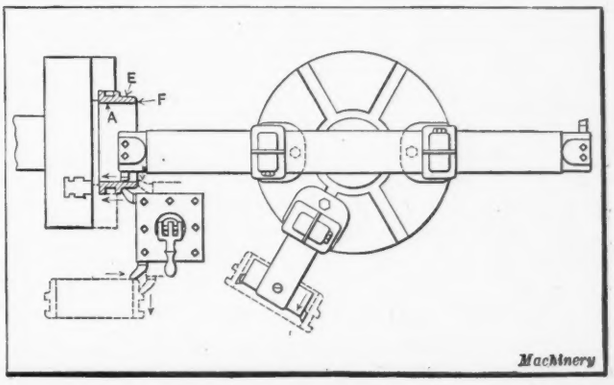


Fig. 8. Diagram of Tool Lay-out for Second Sequence of Turret Lathe Operations on Friction Sleeves

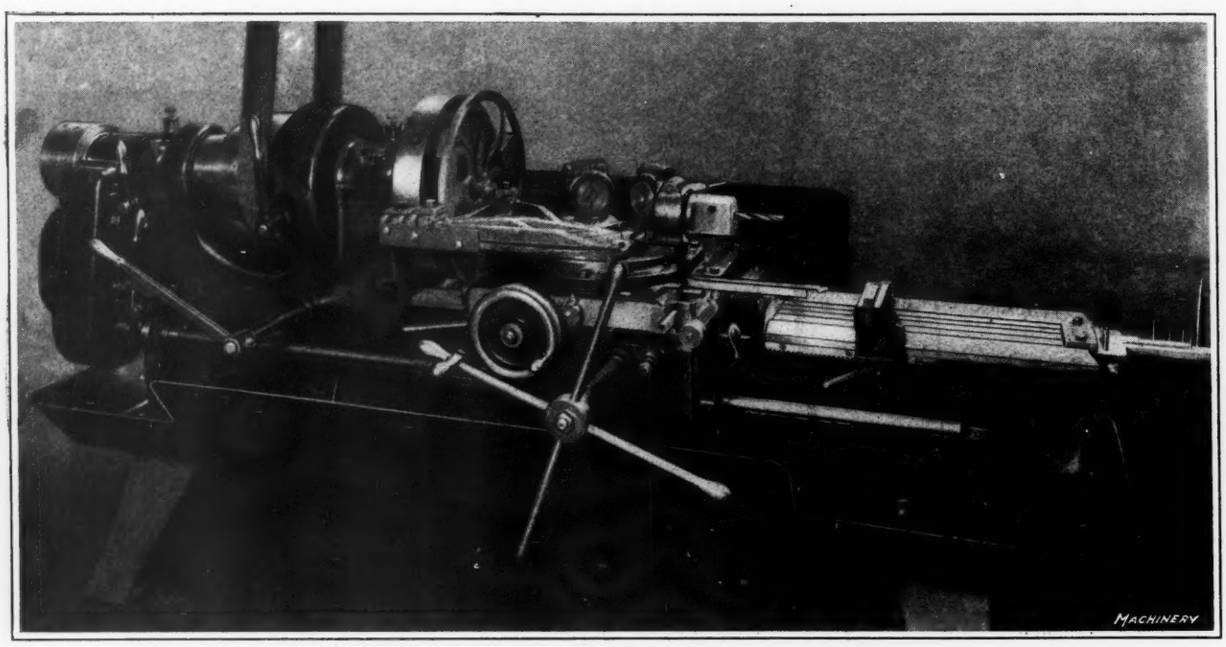


Fig. 9. Work indicated in Lay-out in Fig. 6 in Place on Machine

eye, so that when handwheel *F* is turned, rod *E* will pull the piston back securely into place on the formed nose of work-holding fixture *D*. On the first station of the turret there is a tool for rough-turning outside diameter *H* of the piston, and at the second station a similar tool finish-turns this surface; on the third station there is a tool with four cutter bits for cutting grooves *I*, and at the fourth station of the fixture two tools provide for facing end *J* of the piston and beveling it at *K*. On this job the machining time from floor to floor is 5½ minutes.

Drilling, Reaming, Turning, and Facing Gear Blanks

At the Michigan Washing Machine Co.'s plant in Muskegon, Mich., turret lathes are tooled up as indicated in Fig. 6, to provide for the performance of a sequence of operations on gear blanks of the form illustrated. Reference to this tool diagram will make it apparent that the work is carried by a three-jaw chuck provided with special jaws to grip the work from the inside of the rim. On the first station of the turret there is a twist drill for drilling hole *A*, and this hole is finished by a chucking reamer mounted on the third station of the turret. At the second station an interesting form of tool construction has been developed for simultaneously facing end *B* of the hub, turning outside diameter *C*, and facing sides *D* and *E* of the rim. Evidently such a tool is the means of effecting a substantial saving in the time required for machining gear blanks of this form. Reference to the arrows which indicate the direction of feed movement will make it apparent that the turret at first is moved toward the left to provide for feeding tool bit *F* across the face of the gear blank to turn outside diameter *C*; then the cross-feed movement of the turret is engaged, so that the two straddle tools will be fed in a downward direction opposite the faces *D* and *E*, while the third tool will be fed across the face *B* of the hub. Fig. 9 shows the blank in place in the machine. These gear blanks are made of cast iron, and the machining time for the operations which have been described is 7 minutes from floor to floor.

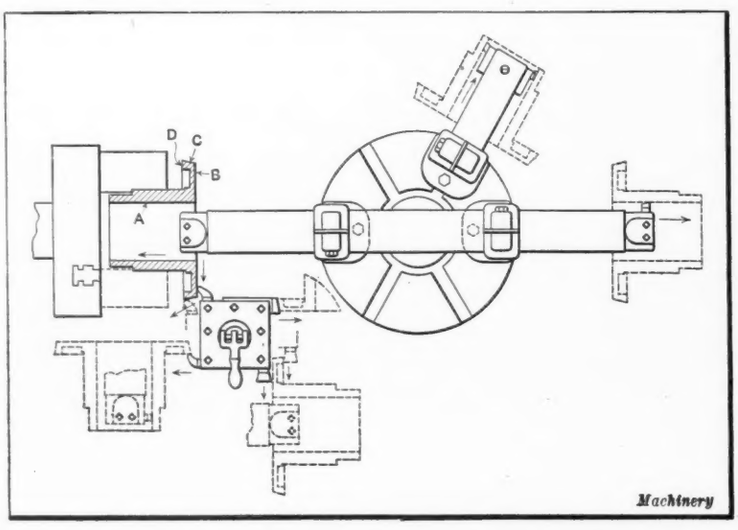


Fig. 10. Tooling of a Turret Lathe for performing First Sequence of Operations on Frictions

Machining Friction Sleeves on the Turret Lathe

Figs. 7 and 8, respectively, show diagrams of the turret lathe tools used in the plant of the Acme Machine Tool Co., Cincinnati, Ohio, for performing the first and second sequence of operations on cast-iron friction sleeves. For the first series of operations it will be evident that the casting is held by its outside diameter in a three-jaw chuck, and a boring-bar on the turret provides for performing a rough-boring operation in hole *A*, Fig. 7. Mounted on the cross-slide there is a turret toolpost, on the first station of which a tool is provided for rough-turning outside diameter *B* and rough-facing end *C*, feed movements as indicated by the arrows being utilized for taking these two cuts. A tool at the second station rough-forms groove *D*. At the third station there is a tool, similar to the one carried at the first station of the turret toolpost, which provides for finish-turning diameter *B* and finish-facing end *C*. At the fourth and final station, a tool is provided for finishing groove *D*. The tools mounted on the carriage are brought into use immediately after the boring-bar on the turret has started taking its cut. These sleeves are made of cast iron, and for the first sequence of operations the machining time is 25 minutes.

Second Sequence of Operations on Friction Sleeves

In Fig. 8, there is shown a tool diagram indicating the way in which the turret lathe is equipped for performing the second sequence of operations on these sleeves. The method of procedure is to perform the first sequence of operations on 100 pieces and then change the tools, with the exception of the

boring-bar on the turret. By indexing the turret through 180 degrees, the opposite end of this bar, which carries the finish-boring tool, is brought into the operating position. As in the previous case, the work is held in a three-jaw chuck, but owing to the fact that it is gripped by faces which have already been finished, special soft jaws are provided to avoid damaging the work. While the boring-bar carried on the first station of the turret is engaged in finish-boring hole *A*, tools mounted on the turret toolpost on the carriage are rough- and finish-turning diameter *E*, and rough- and finish-facing end *F* of the work. On the second station of the turret a Kelly reamer is mounted for use in reaming the bore to exactly the required size. No other tools are operating while the reamer is taking its cut. For the performance of this second sequence of operations the machining time is 18 minutes, the complete time for the two series of operations employed in machining the friction sleeves being 43 minutes.

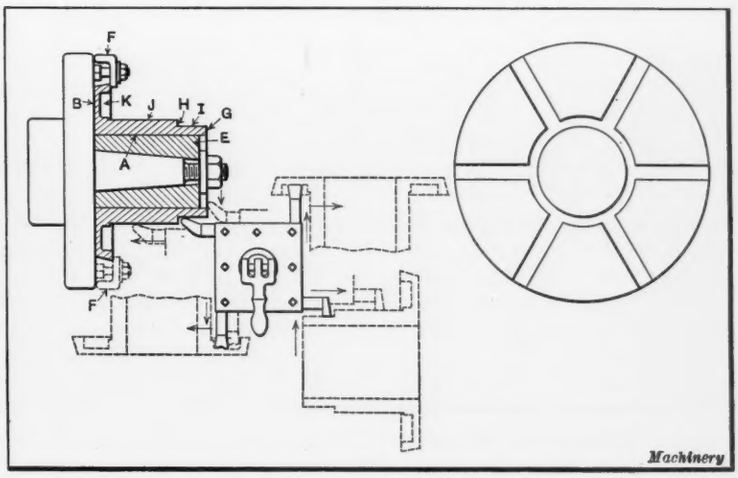


Fig. 11. Tooling of a Turret Lathe for performing Second Sequence of Operations on Frictions

Machining Frictions on the Turret Lathe

At the plant of the Acme Machine Tool Co., Cincinnati, Ohio, turret lathes built by this company are equipped as shown by the tool diagram Fig. 10, to provide for machining frictions for use in lathes of their manufacture. It will be noticed that the work is held by its outside diameter in a three-jaw chuck which is furnished with special soft jaws of suitable form to accommodate the work. On the first station of the turret a boring-bar provides for rough-boring hole *A*, after which the turret is indexed through 180 degrees to bring the opposite end of this bar into position for finish-boring the same hole. Then a second index movement of the turret brings a reamer into line with the work to provide for reaming the hole. On the cross-slide there is a turret toolpost, the first station of which carries a tool for use in rough-facing surface *B* and rough-turning taper *C*, the tool being guided over these faces of the work by feed movements in the direction indicated by the arrows. At the second station there is a tool for rough-facing surface *D*. Then at the third station a tool is provided for finish-facing surfaces *B* and *D*, and at the fourth station a forming tool finishes tapered surface *C*. The tool at the first station merely removes the scale from the tapered surface, while the forming tool at the fourth station is depended upon to attain the desired degree of accuracy. It will be apparent that the tools on the carriage can be in operation while the rough- and finish-boring cuts are being taken in hole *A;* but the reaming of the hole must be performed separately, to assure accurate work. Fig. 12 shows a view of the tools as set up for the first operation. On this job the machining time is 40 minutes from floor to floor.

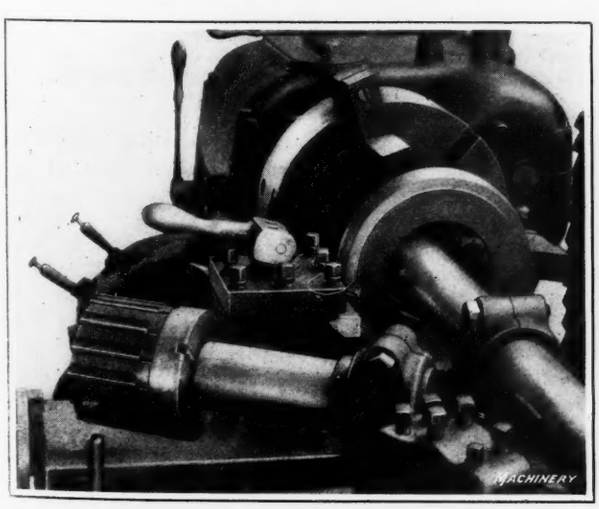


Fig. 12. Tools for First Operation on Frictions, as shown diagrammatically in Fig. 10

Second Sequence of Operations on Frictions

After completing the sequence of operations shown in Fig. 10, it is necessary to reset the work on a machine which is tooled as shown in Fig. 11 to provide for the performance of a second sequence of operations. For this purpose it will be evident that a special work-holding fixture is provided on the nose of the lathe spindle. It consists of a piloted faceplate that provides for utilizing the bore *A* and surface *B*, that were machined during the previous sequence of operations, as locating points for setting up the work on the machine now under consideration. It will be evident that pilot *E* is made to accurately fit reamed bore *A* and that straps *F* hold the work back so that surface *B* is tight against the faceplate. For performing the sequence of operations handled on lathes equipped according to this method, no tools are mounted on the main turret; but there are four tool bits carried by a turret toolpost on the carriage. At the first station, the tool rough-faces end *G* and shoulder *H*, and rough-turns diameters *I* and *J*. To provide for feeding the tool over these surfaces, feed movements are imparted in the direction indicated by the arrows. A tool carried on the second station roughs out the three faces of pocket *K* through imparting feed movements in the direction indicated by the arrows. Then at the third station of the turret, a tool is provided for finish-facing surfaces *G* and *H* and finish-turning diameters *I* and *J*. And finally, the turret toolpost is indexed to its fourth station to bring a tool into operation for finishing the three faces of pocket *K*, through imparting to this tool feed movements similar to those which were employed for the tool at the second station of the turret. These frictions are made of cast iron, and for this second sequence of operations the machining time is 40 minutes from floor to floor.

* * *

SAFETY ENGINEERING IN TECHNICAL SCHOOLS

The National Safety Council has made several suggestions for improving the education in engineering colleges with regard to safety of workers in the industries. Safety education in engineering colleges, says the council, should not be confined to a course intended specifically for safety engineers. An effort should be made to impress upon all engineering students the fact that safety in the industries is necessary to engineering efficiency, so that the students, when entering practical work, will know that the full measure of efficiency cannot be obtained without safe working conditions. Safety engineering, therefore, should be worked into all engineering courses. Such courses as machine design, shop practice, and industrial management are particularly suitable for including safety engineering education. The matter of safety in the industries should be presented to the students as a subject definitely related to engineering efficiency rather than as a humanitarian subject.

INTERNAL GRINDING CHUCKS

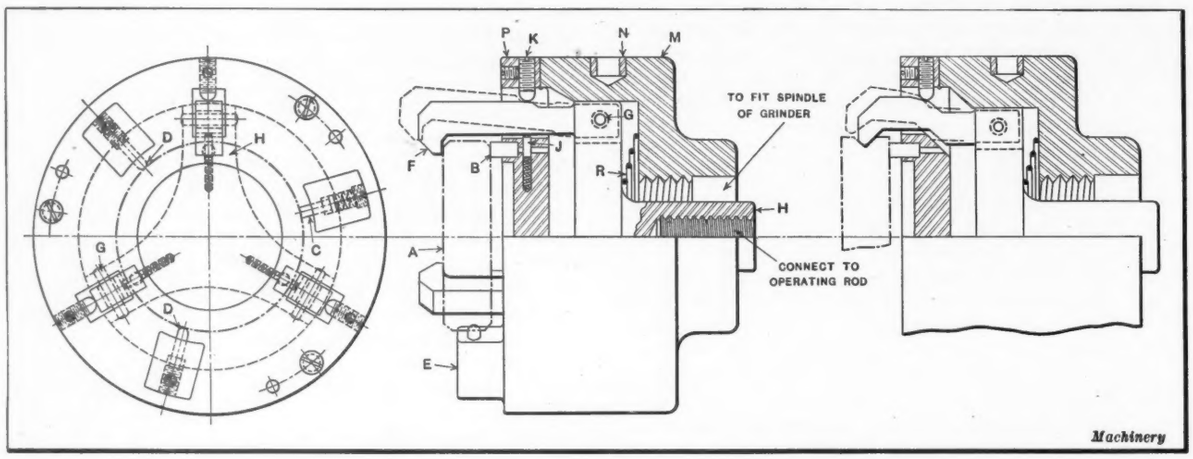
By F. WILLIAM STEIN

Trouble is often experienced in chucking parts that must have the bore ground at right angles to a side and concentric with the periphery, particularly when a collet chuck is used, or one employing the usual design common to three- and four-jaw chucks. This trouble, on work of thin-wall section, is caused by the work springing while being clamped in the chuck, so that when this frail work is removed the parts spring back into shape, leaving the ground hole out of round. For service on work of this kind, the chuck described in this article has been in successful use for a number of years.

By referring to the illustration it will be seen that two separate forces are employed in holding the work *A* in place, a radial force and an axial force. This is the distinguishing characteristic of the chuck, and it eliminates the possibility of distortion. The seat for the work is provided by three hardened pins *B*, the top surfaces of which are face-ground, after they have been assembled and the chuck mounted on the grinding machine spindle, a provision which enables the bore to be ground normal to the face. The work is located on these pins, concentric with the spindle center, by means of three pins which are carried in bosses *E* positioned radially, and equally spaced with reference to the circumference of the work. One of these pins is a spring plunger *C*, the coil spring which actuates it being sufficiently stiff to force the work against pins *D* and hold it by radial force. These pins are hardened and ground, the adjustable ones *D* being a close fit in the reamed holes of the bosses. The opposite ends of the pins are threaded and slotted so as to be readily adjusted to suit different diameters of work that is to be ground. Set-screws are provided in the bosses for locking the pins in place after they have been properly adjusted.

The axial force employed to hold the work is exerted through three jaws *F*, which are hinged to the legs of spider *H* and extend through holes in cover plate *P*, and hook over the outside of the work. The extremities of the legs of spider *H* are a close sliding fit within the chuck body *M*, which is screwed on the spindle of the machine. The shank of the spider extends through the body and is connected to the operating handwheel by means of a rod extending through the spindle. The function of plungers *J* is to force the jaws into contact with the adjusting screws *K*, so that as the handwheel is turned and the spider traversed from right to left, the jaws, on account of the contour of their upper surface, will be forced radially outward to the position indicated by dotted lines in the illustration, thus releasing the work. The conical coil spring *R*, interposed between the spider and inner wall of the body, exerts an axial force on the spider and holds the jaws in the forward position. On account of the large number of holes necessary in cover plate *P*, this part is made from cast steel and is attached by means of set-screws and dowel-pins to the cast-iron body, on which it is accurately centered. The bosses that carry the radial locating pins are attached to this plate. The minor details of the chuck consist of headless set-screws for locking the adjusting screws *K* in place; hardened steel bushings *G* in the jaws to reduce the wear at this joint as much as possible; and steel bushings *N* in the spanner wrench holes in the chuck body.

The view shown at the right-hand side of this illustration is an adaptation of the principle incorporated in the chuck just described. This chuck is operated in the same way as the other chuck, but, being designed for work which must have its bore ground concentric with the vee on its circumferential surface, the jaws are made to fit this vee. Certain other modifications are also made, so that the force exerted by the jaws is normal to the side of the vee against which they act, rather than axial. For this reason, the shape of the jaws is changed to agree with conditions. The inner edge of the three holes through which the jaws extend, is beveled to produce a "camming" surface to force the jaws radially outward, in place of the spring-plunger arrangement. In other respects the construction of the chuck is the same as that previously described. It is suggested that a small air cylinder might be substituted for the handwheel on the operating rod where quick manipulation is desired to save chucking time. It will be noticed in the illustration that for the sake of clearness, the chucks are shown in the conventional method with some of the projections omitted.



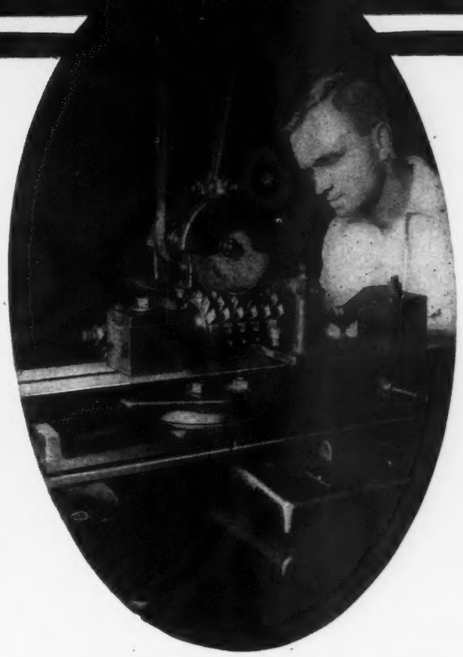
Types of Chucks used for holding Rings and Similar Parts when grinding the Bore

* * *

DEMAND FOR HIGH-PRODUCTIVE MACHINE TOOLS IN SWEDEN

At the beginning of this year, the eight-hour day was established by law for all the industries in Sweden, thus reducing the former ten-hour day by 20 per cent. Wages are also much higher than formerly, the hourly rates being from three to four times what they were before the war. Therefore, those manufacturers who wish to keep the production at the same level as it was with the longer working day, find it necessary to increase their machine equipment and to obtain equipment of high productive capacity, and in doing so will require a considerable number of American machines. The Swedish machine tool builders who make machines and tools of good quality are quite active at the present time, there being in round numbers from thirty to forty builders of machine tools in Sweden, not counting the firms in other lines that built machine tools temporarily during the war.

Sharpening Hobs and Cutters



Important Points to be Considered in Obtaining Good Results in the Cutting of Gears

By CARL G. OLSON, Chief Engineer, Illinois Tool Works, Chicago, Ill.

HOBS and cutters should be kept sharp by grinding the faces of the cutting teeth. This sharpening is of the utmost importance, and great care should be taken to retain the correct angles and surfaces necessary to maintain the accuracy of the work for which the hobs or cutters were made.

The grinding machines used for sharpening hobs should preferably be machines made for this work, but, in general, the ordinary universal cutter grinder is well suited for the purpose. It is essential that the grinding machine be properly adjusted and free from vibration. Particular attention should be given to the machine centers; they should be true and of the correct taper. The grinding wheels should be of medium grade, and the peripheral speed should be about 5000 feet per minute.

In grinding, take light cuts and move rapidly through the gashes of the hob or cutter. It is better to go around several times, taking light cuts, than to risk drawing the temper of the cutting edges. This applies particularly to carbon steel tools, but it is well to avoid heating high-speed steel also.

Another important point is to use arbors that are perfectly straight and true, for holding the hobs or cutters. These arbors should have large clean centers of 60-degree taper, and the depth of clearance at the bottom should be sufficient to clear the points of the centers of the grinding machines or their fixtures. The arbors should be tested by an indicator while being revolved on centers, as shown in Fig. 1. A special gage with a 60-degree angle should be used for frequent checking of the arbor centers. (See Fig. 2.)

New hobs are mounted on an arbor, placed in the grinding machine, and ground on the face of the teeth until proper sharpening has been obtained and also until all of the teeth have been ground concentric with the axis of the hob. The indicator in Fig. 3 registers the eccentricity of the teeth after the hob has thus been sharpened. A variation of 0.001 to 0.002 inch, depending on the size and pitch of the hob, may be allowed.

Grinding Radial and Under-cut Teeth

The teeth are usually ground with radial cutting faces (see Fig. 4), but new developments have recently brought out hobs with hooked or under-cut teeth. In sharpening, the cutting faces should be maintained radial in hobs designed for radial teeth, and it is equally important that the angle of under-cut in hooked hobs and cutters be maintained throughout the life of the tool.

Fig. 5 shows a cutter so ground that the cutting faces of the teeth have "negative rake." This is incorrect under all circumstances, as the cutting action is reduced to what is generally called a "drag." Fig. 6 shows the position of the grinding wheel in grinding an under-cut. This is also wrong for cutters designed to be ground radial, but in the new type of cutters previously referred to, this under-cut becomes a part of the design and should be maintained to the angle specified. This is the angle a between the plane of the cutting face and a radial line.

Grinding the Heels or Rear Ends of the Teeth

To facilitate sharpening by the use of an ordinary universal cutter grinder, the teeth of straight-gashed hobs are ground on the heel to an even length for the purpose of indexing as in Fig. 7. A measuring gage, shown in Fig. 8, is used for checking after this operation. With the backs of the teeth thus ground resting against the index finger, as in Fig. 9, the hob may be sharpened repeatedly and the length of the teeth maintained equal to each other, keeping the points of the teeth concentric with the axis of the hob.

Sharpening Helically Fluted Hobs

When sharpening helically fluted hobs, the table of the grinding machine should be swiveled to correspond with the

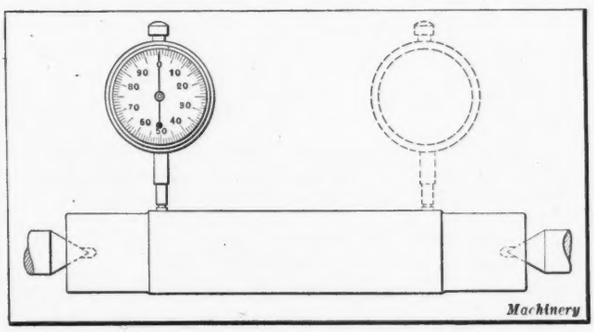


Fig. 1. Method of testing Accuracy of Arbor used for holding Hobs and Cutters while sharpening

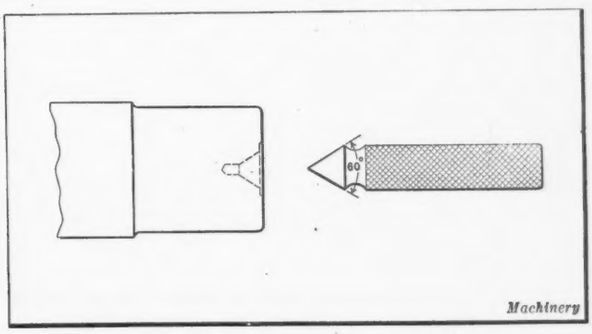


Fig. 2. Gage with 60-degree Included Angle, which is used for testing Center Hole in Arbor

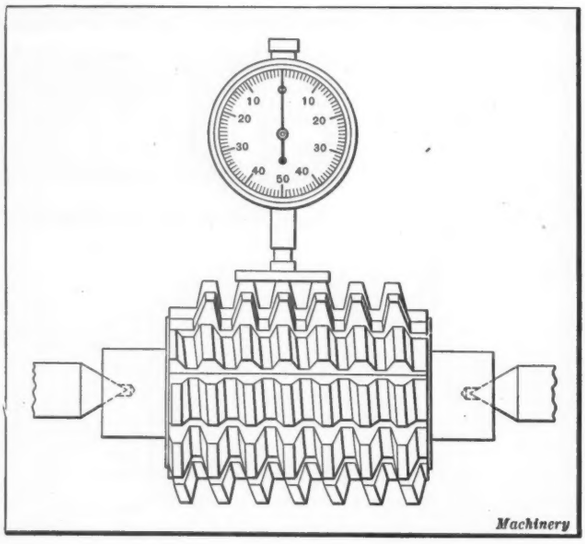


Fig. 3. Testing Eccentricity of Hob Teeth with Indicator, after sharpening

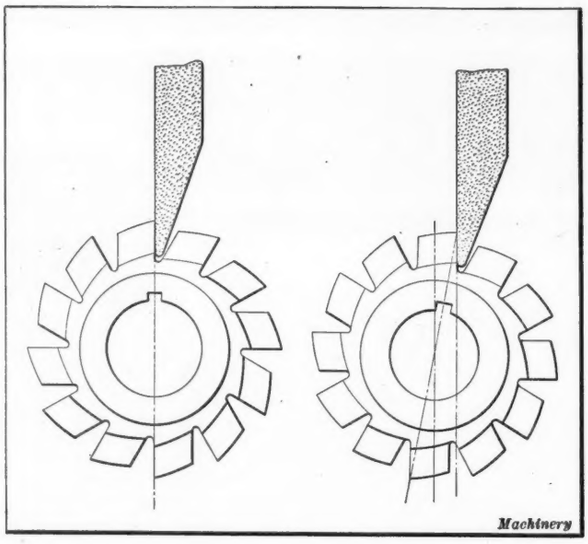


Fig. 4. Wheel set for grinding Radial Cutting Faces

Fig. 5. Wheel incorrectly set, producing Negative Rake

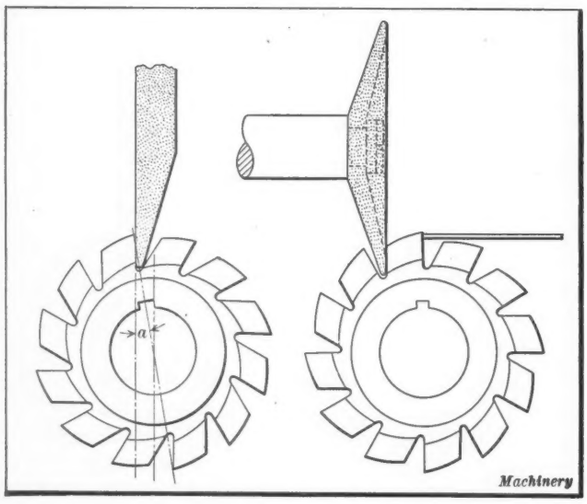


Fig. 6. Proper Position of Wheel when Under-cut Teeth having Positive Rake are desired

Fig. 7. Wheel set for grinding "Heels" or Rear Ends of Teeth to facilitate Indexing

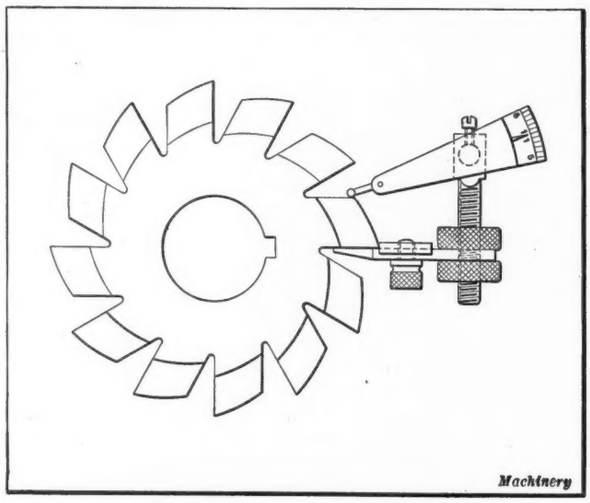


Fig. 8. Gage used for testing Hob Teeth to see that they are of Uniform Length after the "Heels" or Rear Ends of the Teeth have been ground as illustrated in Fig. 7

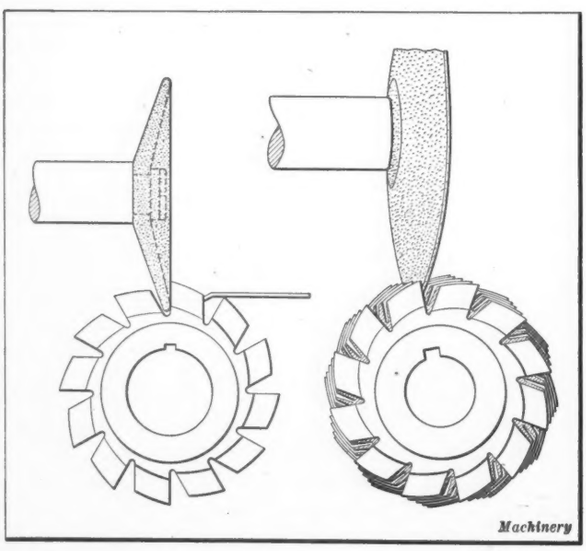


Fig. 9. Sharpening Straight-gashed Hob by indexing from the Backs of the Teeth

Fig. 10. Angular Side of Wheel set for sharpening a Helically Fluted Hob

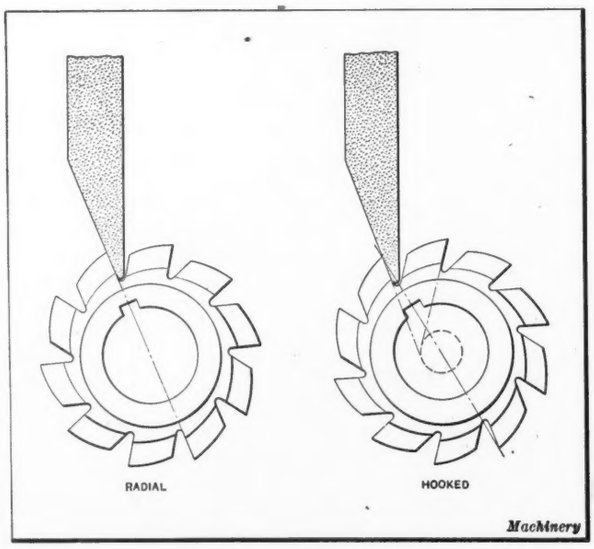


Fig. 11. Using Angular Side of Wheel for sharpening Radial Teeth on Helically Fluted Hob

Fig. 12. Positions of Wheel and Helically Fluted Hob having Under-cut Teeth

angle of the flutes. This angle will be found stamped on one end of the hob. A helically fluted hob is sharpened by using the angular side of a dished grinding wheel, as shown in Fig. 10. To produce radial cutting teeth this grinding wheel must be set off center until the angular side of the wheel is radial to the center of the hob, thereby producing radial tooth faces, as shown in Fig. 11. When a hooked helically fluted hob is ground, this setting is altered until the grinding wheel produces the required angle of hook, or under-cut, as shown in Fig. 12.

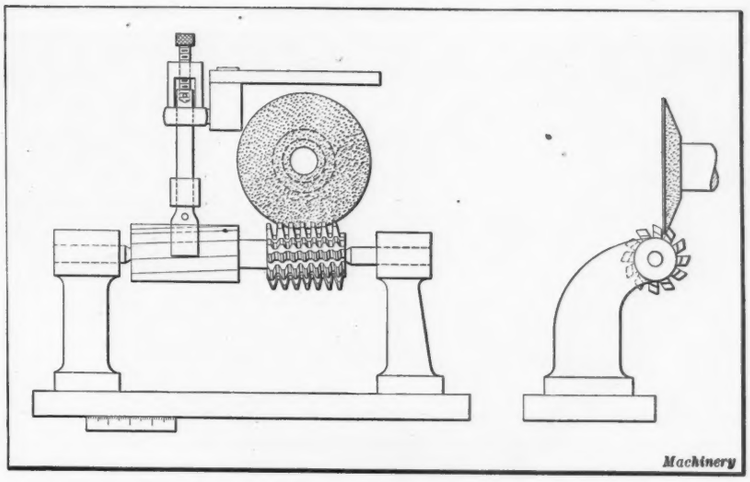


Fig. 13. Former mounted on Arbor with Helically Fluted Hob to give the Required Rotation when sharpening the Teeth

The faces of the teeth of a helically fluted hob cannot be ground with the straight side of a wheel, because the hob teeth present a helical surface, and the straight side of the wheel would interfere with some of the teeth. Therefore the convex side of the wheel is used, as there is no trouble from interference owing to the curvature of the wheel; this curvature does not prevent grinding either radial or hooked teeth correctly.

Unlike the straight-gashed hob the helically fluted hob is indexed from a former having helically milled flutes equal in lead and in number to the flutes in the hob. This former is mounted on the same arbor with the hob, and the arbor is placed between the centers of the grinding machine. A contact finger, mounted in a holder secured to the frame of the machine, turns the former as the table is moved, thus giving the proper rotation to the hob. The contact finger, or guide, is provided with an adjusting arrangement for feeding the teeth of the hob against the grinding wheel, as shown in Fig. 13.

After resharpening hobs or cutters, it is well to mount them on an arbor between the centers in a testing machine or lathe, to check the points of the teeth with an indicator, as in Fig. 3, and thereby make sure that the cutting teeth are concentric.

Fixture for Testing Faces of the Teeth

A fixture for testing the faces of the teeth is shown in Fig. 14. This fixture should be used in the grinding department with proper instructions to the men in regard to angles for sharpening. In using this fixture, the hob or cutter is placed on a stud. The gage attached to the indicator lever is inserted into the gash of the hob until the point of one hob tooth touches the flat end of the indicator lever. Then the hob is rotated counter-clockwise until the gage is brought parallel to the tooth face, the angle being shown on the scale by a pointer attached to the indicator lever.

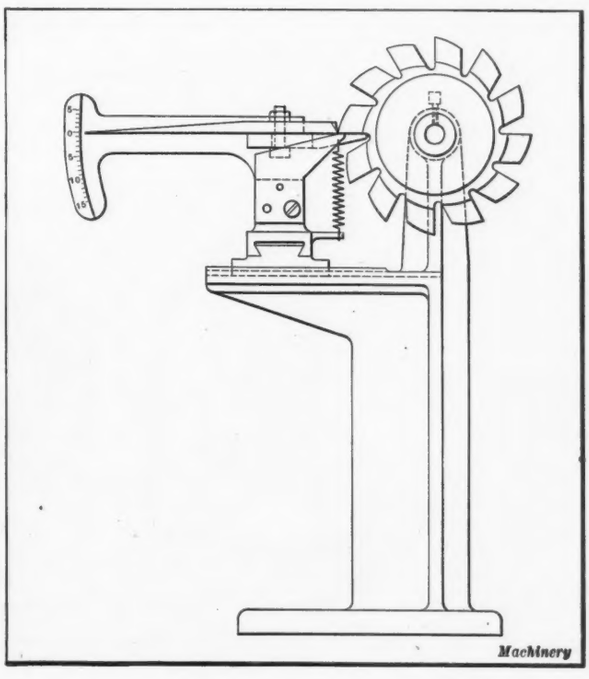


Fig. 14. Fixture for testing Faces of the Teeth after sharpening

It will be noticed that the indicator lever is fulcrumed in line with its flat end. This flat end also serves as a stop for the cutter teeth as they are brought into position. This feature enables the fixture to measure correctly the angles of the teeth of any size of cutter that is within its range.

The contact gage being perfectly straight also checks the straightness of the tooth face. This is done by noticing the admission of light between the tooth and the gage. For convenience in making this light test, the fixture has been made high enough to hold the work level with the eyes of the operator when it is used on a work-bench.

Special Hob-sharpening Machines

Special machines made for the purpose of sharpening hobs have been designed, and several types of these machines are on the market. In these machines, some of which are automatic, the lead of the helix may be adjusted to conform to the lead of the flutes in the hob. This is a great convenience, as no helical formers are required in this case. In plants where several hobs are sharpened daily, it is advisable to purchase one of these special machines, but where only a few hobs are used the universal cutter grinder will give satisfactory results.

* * *

CANADIAN INDUSTRIAL FATIGUE COMMITTEE

The Canadian Government has recently established a committee on industrial fatigue for the purpose of making the knowledge and experience of medical science, in its relation to industrial health and efficiency, available for all industries. Thus employers will be enabled to increase production by reducing lost time and labor turnover, and employes will be helped to maintain steady wages and employment by the reduction of preventable illness and hardship of working conditions. The principal objects are to offer manufacturers the assistance of scientific laboratories in solving the health problems presented by particular processes in their plants; to establish an intelligence bureau where up-to-date information on general and specific problems of industrial hygiene is kept; and to cooperate in investigating conditions in different industries, the occurrence and causes of sickness, and the actual relation existing between the hours of work, working environment, and production. An office has been opened at the University of Toronto, and other offices will be opened later.

Measuring Balls and Plugs by Light-wave Method

By H. L. VAN KEUREN
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IT would be difficult to find a mechanical product that is of greater utility or refinement in regard to accuracy than steel balls for bearings, especially when one considers the great quantities produced. Accuracy, or more particularly uniformity, is a necessity demanded by the conditions under which steel balls are used; and while present efficient and rapid gaging methods secure uniformity for ordinary requirements, a new and practical application of light-wave measurement makes possible most accurate shop measurements of balls or rollers required for work of special refinement. The light-wave method may also be applied readily to the measurement of plain cylindrical plug gages. Nearly everyone demands in these plug gages an accuracy of 0.0001 inch or better. By extending the principles of interference of light measurement to diameter measurements, it is no longer necessary to guess or take things for granted in determining the ten-thousandth part of an inch in the production and use of plug gages. The unit of measurement, which is the half wave length of light (approximately 0.00001 inch), eliminates all guesswork, and no difficulty is encountered in securing fractions of this unit, making possible measurements within a few millionths inch.

There is nothing complicated about the procedure; in fact, it is most rapid, and the principles are in part familiar to every mechanic. Concerning the scientific details of light-wave measurement, it may be stated that while science is the foundation, as is the case in any real development of the present age, a knowledge of these details is not necessary in order to become proficient in measuring by light waves. However, it is of importance to know about the occurrence of interference bands, and how to interpret their meaning. Therefore in the following explanation there is given only the fundamental facts that are of utility in making the application of light waves for diameter measurements.

A Few Facts about Interference Bands

Recent articles on the measurement of flat precision gage-blocks by light waves should make unnecessary a detailed explanation or proof of the following facts:

1. Light is a form of wave motion. Different colors of light have different wave lengths ranging from 0.0000169 inch (the average length of violet waves) to 0.0000268 inch for red waves. Daylight contains all the colors and has an average wave length of approximately 0.00002 inch.

2. Monochromatic light is light in which one wave length or color predominates. The following explanations assume a monochromatic light having a wave length of 0.00002 inch.

3. An optical flat is a practically flat transparent test surface. Unlike a lens, it has no magnifying power.

4. Interference bands, which occur between the contacting surface of an optical flat and a flat or nearly flat reflecting surface, appear as merging colored bands or fringes in daylight; and as alternate light and dark bands in monochromatic light.

5. When a series of straight interference bands occurs between two flat contacting surfaces, there is always a wedge of air between them, contact being at one side only.

6. The bands take a direction at right angles to the slope or direction of the wedge.

7. The number of bands per inch indicates the steepness of the wedge, which increases in thickness from the point or side of contact at the rate of one-half wave length (0.00001 inch) per dark band.

8. The pronounced light spot indicates the point of contact.

9. The dark interference bands are not light waves, but simply show the points or spaces where the light waves reflected from one surface interfere with the waves reflected from the other surface. The light spaces show the points of

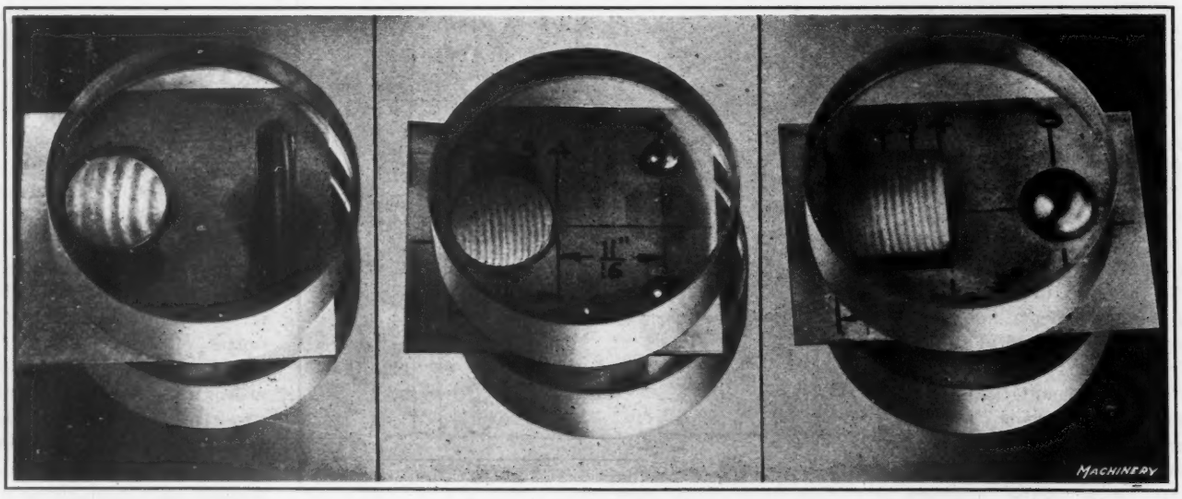

Fig. 1. Measuring the Diameter of a ¼-inch Plug Gage by comparing it with a ¼-inch Gage-block

Fig. 2. Comparing Two Balls for Uniformity. Bands are almost Parallel with Line connecting Ball Centers

Fig. 3. Measuring the Diameter of a ½-inch Ball by comparing it with a ½-inch Gage-block

reinforcement. It is the dark interference bands that indicate the useful measuring unit of 0.00001 inch.

10. Straight parallel and evenly spaced bands indicate a flat surface, and curved and irregular bands indicate a curved or irregular surface.

One of the earliest devices to be used in mechanics was the wedge. It is this elementary mechanical principle that is employed in comparing the length of two flat gage-blocks, and also for measuring diameters of cylindrical plugs and balls. Two optical flats are used to form the wedge. The thickness of the wedge is fixed at one point by the thickness or length of a known standard gage-block, and at another point by the diameter of the ball or cylinder being measured. From the position, direction, and spacing of the interference bands, the slope of the wedge is found and, consequently, the exact amount that the ball or plug is larger or smaller than the standard is easily determined. A few examples will serve to illustrate the method of procedure.

Measuring an Over-size Plug

The measurement of a ¼-inch plug which is straight (that is, not tapering), but which is found to be over size by 12 units, or 0.00012 inch, is indicated in the drawing Fig. 4. The 0.250-inch circular gage-block standard is wrung on the lower optical flat, and the plug being tested is placed a definite distance away from one side of the gage-block. Usually, in order to make the calculation easy, it is placed a distance away from the gage equal to the width or diameter of the gage. A cardboard templet, as shown, serves to locate the plug at the proper distance.

Now the thickness of the wedge between the two flats where contact is made by the upper flat on the standard gage-block is just 0.250 inch. The wedge is increasing in thickness from this point of contact by 0.00001 inch for every dark band. Thus, counting six bands across the gage, which is a distance half way to the center of the plug, it is evident that the plug is 0.00012 inch large or over size.

Measuring an Under-size Plug

The location of the point of contact between the upper optical flat and the standard gage-block determines whether the plug is large or small. As shown in Fig. 4, when the plug is large the point of contact is located on the side of the gage away from the plug. Conversely, when the plug is small the point of contact is located on the side of the gage near the plug. Thus, in Fig. 5, it will be seen that as four and one-half bands can be counted from the point of contact across the gage, the upper flat slopes upward or away from the surface of the gage-block 0.000045 inch in a distance of ¾ inch, which is the diameter of the gage-block. The flat slopes downward to the plug (which is located ¾ inch away), by the same amount, and the plug is therefore found to be 0.000045 inch under size.

Tapering Plugs

In the two previous examples, both the over-size plug and the under-size plug were assumed to be straight, or without any taper. In actually measuring work, it is very easy to detect the slightest taper, simply by noting whether or not the bands are parallel to the axis of the plug. If the bands are parallel to the axis of the plug, it is straight; but if the bands are at an angle to the axis of the plug, it is tapering. Thus in Fig. 6 there is shown a ¼-inch plug which tapers from 0.00004 inch over size on one end to 0.00012 inch over size on the other end.

Further examples are shown in the photographs reproduced in Figs. 1, 2, and 3. Fig. 1 shows the measuring of the diameter of a ¼-inch plug gage by comparing it with a ¼-inch gage-block. The plug is under size by six bands or 0.00006 inch. The bands are practically parallel to the axis of the plug, indicating that the plug is not tapering. Fig. 2 shows a method of comparing two balls for uniformity. The bands are almost parallel to the line connecting the centers of the balls. The balls are, therefore, very nearly the same size. Variations would be shown by the angularity of the bands. Fig. 3 shows the method used for measuring the diameter of a ½-inch ball by comparing it with a ½-inch gage-block. This method of measuring the ball diameter shows that the ball is under size by an amount equivalent to fourteen bands or 0.00014 inch.

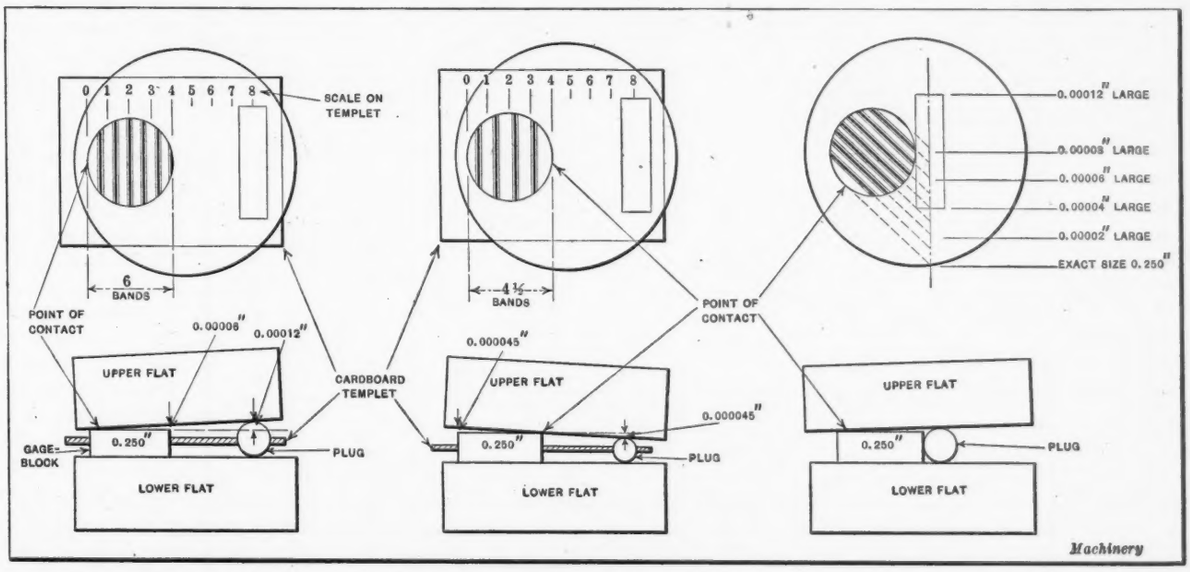

Fig. 4. Method of comparing a Cylindrical Plug with a ¼-inch Standard Gage-block

Fig. 5. An Under-size Plug. The Point of Contact is on the Side Adjacent to the Plug

Fig. 6. A Tapering Plug. The Bands incline relative to the Plug

Measuring Plugs of Small Diameter

It is often necessary to measure the diameter of plugs or cylinders of very small diameter, such, for instance, as thread-measuring wires. This can easily be accomplished by the method previously described. A standard is selected of convenient length or thickness, say ½ inch, and a combination of gage-blocks is placed under the wire or small plug to be measured. Preferably the combination of blocks should be chosen so that the length of the combination plus the diameter of the wire is slightly higher (about 0.0001 inch) than the standard gage. The various blocks of the combination should be carefully wrung together, and the combination should be wrung on the flat as well as the standard.

Points to Observe when Taking Measurements

When measuring diameters by this method, one encounters little difficulty in making most accurate measurements. In fact, the apparatus and procedure are so simple that there is little chance for errors to occur in the measurement. However, a few suggestions will be included which will assist in obtaining proficiency in making the measurements.

When wringing the standard gage-block on the lower optical flat, care should be taken to get the gage in good contact. When a flat gage is properly wrung on the flat, no bands can be seen in monochromatic light, and no tinge of color is discernible in daylight.

Small nicks or burrs on the gage-block may prevent its being properly wrung on the flat. These nicks should therefore be removed.

The plug or ball being tested and the upper surface of the gage-block should be clean and dry.

A slight pressure is exerted on the upper flat to make sure that it is in contact all the way along the plug, as well as in proper contact with the gage-block standard. After contact is once secured, the pressure can be reduced.

It has been shown that with two optical flats and a source of monochromatic light, it is possible to make very accurate diameter measurements. While these explanations give an idea of the extreme accuracy obtainable, they do not convey the idea of the rapidity with which the measurements can be made. Owing to the very simplicity of the outfit required, there is no time lost in making adjustments and detailed preparations, as would be the case if an elaborate measuring machine were required. Indeed, it is almost necessary to see or actually perform the measuring operations with the optical flats to realize the advantages and efficiency of the optical method.

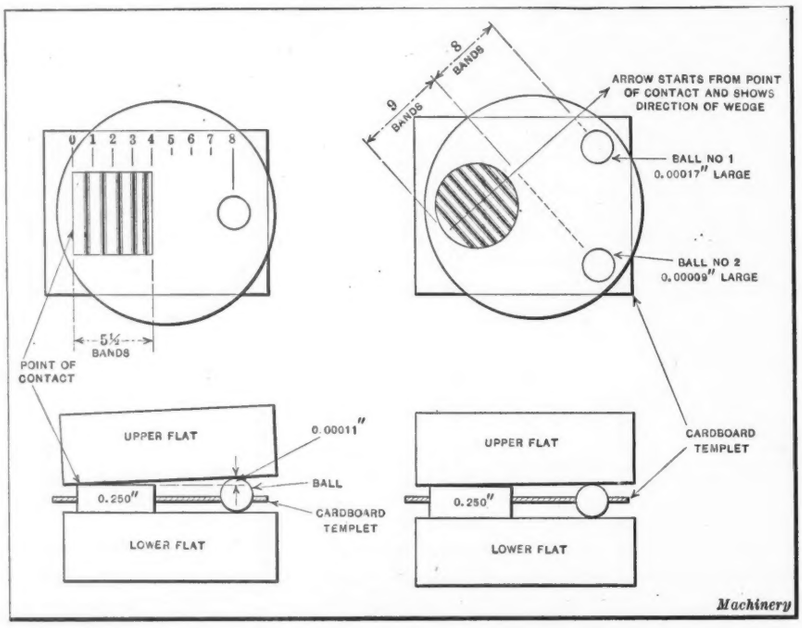

Fig. 7. An Over-size Ball

Fig. 8. Selecting Balls of Uniform Size

Measuring Diameters of Steel Balls

The measurement of the diameter of a steel ball is even more simple than the measurement of a cylindrical plug. The procedure is illustrated clearly in Fig. 7, which shows the measurement of a ball in comparison with a 0.250-inch square gage-block standard. The ball is 0.00011 inch over the standard size of ¼ inch.

It will be noted that the measurement of the ball is shown in comparison with a square gage-block, rather than a round gage-block as was the case with the plug measurement. The fact is that either the round or the square gage-block may be used for measuring the plug or the ball. However, the round gage is preferable in measuring the plug, inasmuch as the upper flat, which makes a line contact with the plug, adjusts itself automatically to the proper point contact on the round gage-block.

The square gage-block provides a line contact with the upper flat, and this serves to steady the flat when it is making point contact on the steel ball. In using the round gage for ball measurement, the upper flat is either manipulated with the hand or balanced, so that the interference bands run at right angles to a line drawn through the center of the ball, the center of the round gage-block and the point of contact of the upper flat on the gage-block.

Selecting Balls of Uniform Size

If it is simply desired to select a number of steel balls of the same size, a templet would be used which provides for two balls, located as shown in Fig. 8. If the interference bands appearing on the gage-block are parallel to a line between the two balls, then the two balls are of the same size. In the example shown in Fig. 8, the bands make an angle with the center line of the two balls, and it will be noted that the arrow, which is drawn from the point of contact of the upper flat on the gage-block, perpendicular to the bands, points in the general direction of the larger ball. The arrow shows the direction of the wedge, and the larger ball is, of course, farther out on the wedge. The difference in diameter is readily estimated as indicated in the illustration.

General Application of Light-wave Method

The application of the foregoing principles makes possible measurements in which there is absolutely no question about avoiding an error of 0.0001 inch, as the unit of measurement is 0.00001. If necessary, this unit may be divided even as far in certain cases as a tenth of a unit or one millionth of an inch. However, the question often arises, how does this apply to production? Production, today, is either on the basis of, or is tending toward the basis of, enormous schedules for the manufacture of interchangeable parts. This requires definite limits on important dimensions and gages to determine these limits. Limits of 0.002 inch are common on production work. Now an error of 0.0001 inch on a gage, say a plug gage for a hole, either robs the working tolerance of 5 per cent, making production more difficult, or it means a loss of life in the gage itself of 30 per cent (the allowable gage wear being 0.0003 inch). Thus by applying the few essential rules of light-wave measurement, one can be sure of the ten-thousandth inch and easily measure in hundred-thousandths. The result is better work and more economical tools.

* * *

A three-ton motor truck has completed the trip from Los Angeles to New York—3450 miles—in 13½ days, making an average of 260 miles a day. Motor-truck enthusiasts see in this record an indication of the value of the motor truck for long-distance hauls, but it is entirely out of the question for the motor truck under normal conditions to compete with the railways for long-haul business. For short-haul traffic the motor truck is the most economical freight vehicle, but the limit of its successful competition with the railroad may be placed at about 100 miles. When motor trucks can successfully compete with railroads over longer distances than this, it is an indication that the railroad service has broken down.

CHART FOR DETERMINING FIT ALLOWANCES

By J. B. CONWAY

The accompanying chart was evolved to facilitate the establishment of limits and tolerances for various classes of fits. It is based upon the formulas given on page 880 of MACHINERY'S HANDBOOK. The chart presents an interesting comparison with the tables given on the same page, as the values established by the formulas vary somewhat from those tabulated. From this comparison it would seem that the tabulated values are, as a whole, more convenient to work to than some of the closer limits obtained by means of the chart. However, any reference table of this nature is always subject to modification, depending upon the nature

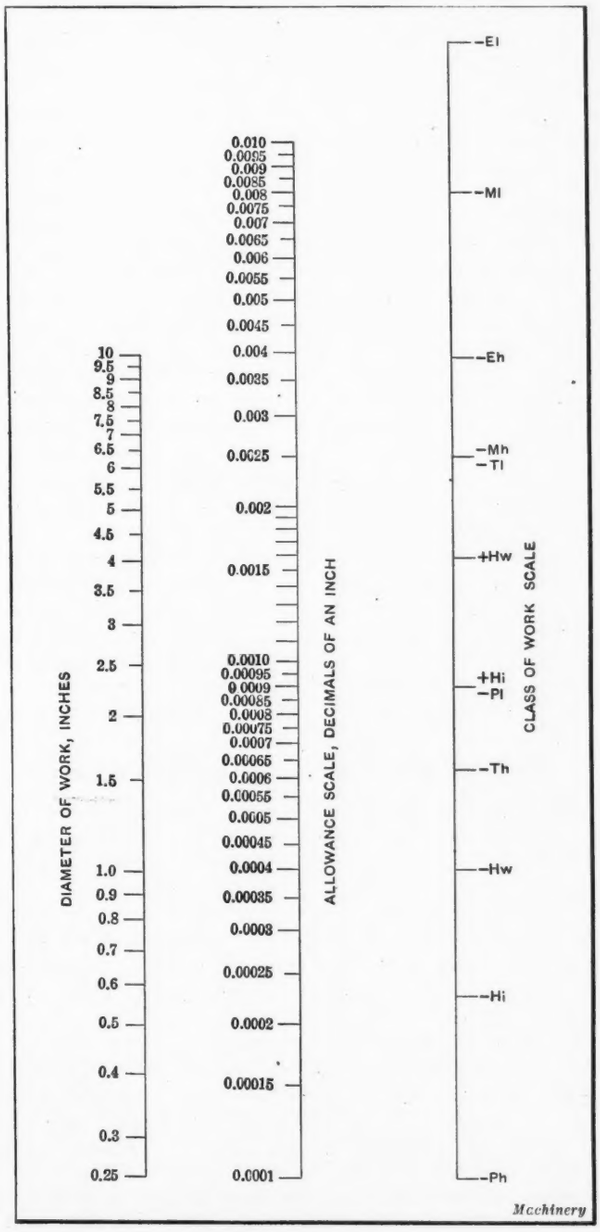

Chart for determining the Tolerances and Limits to be allowed for Various Classes of Fits

of the work and mating parts, and the degree of accuracy and refinement desired. In some instances, where closer limits are required than those given in the tables, the chart will supplement them directly, interpolation being unnecessary.

Reference to the chart will show that it consists of three graduated scales. The left-hand scale is graduated to represent diameters of parts or holes on which fit allowances are to be established; the middle scale gives the fit allowances to be provided; and the scale at the right of the chart is graduated to indicate the class of work. The method of using the chart is to place a straightedge so that it will extend from the graduation on the diameter scale corresponding to the diameter of the work or hole, to the graduations on the limit scale representing the high and low limits for the class of fit desired. The allowances for each limit can then be read directly on the middle scale. The capital letter in each symbol and letters "i" and "w" represent the class of fit; thus Hi represents fit for inspection plug gages, standard holes; Hw, fit for working plug gages, standard holes; P, shafting push fit; E, engine and ordinary shafting fit; M, shafting fits for high speeds and good machine work; T, fit for fine tool work. The letter "h" after any capital letter indicates the high limit and the letter "l" the low limit. Wherever the plus sign is placed before the symbol it indicates that the allowance is to be added to the nominal size of the part or hole, while the minus sign indicates that it is to be deducted.

The following example will illustrate the method of using the chart: Assume that a standard 2-inch hole is to be fitted with a shaft, the class of work requiring an "E" fit as established from the chart. The high-limit allowance is found by first laying the straightedge so that it extends from the graduation on the diameter scale marked 2 inches to the graduation on the limit scale marked — Eh, and then reading the dimension nearest the intersection on the allowance scale, which in this case will be found to be 0.0017 inch. The low-limit allowance is next found by shifting the right-hand end of the straightedge to — El, and then reading the dimension at the intersection on the allowance scale as before. The low-limit allowance will be found to be 0.0035 inch. The tolerance allowed on the shaft will be the difference between the two limits or 0.0018 inch. As minus signs are placed before the symbols of both the high and low limits, it is obvious that the allowances must be deducted from the nominal diameter of the hole to find the limits on the diameter of the shaft. Thus $2 - 0.0017 = 1.9983$ inches, the largest permissible diameter of the shaft and $2 - 0.0035 = 1.9965$ inches, the smallest permissible diameter. The initial clearance between the shaft and the hole is, of course, 0.0017 inch, provided the hole is exactly 2 inches in diameter. The high- and low-limit dimensions must always be changed when the tolerance allowed on the hole permits it to be smaller in diameter than the nominal size if the tolerance on the part obtained by means of the chart is to be maintained.

The symbols employed to represent the classes of fits are readily remembered, and if the classes of fits are specified on the drawings, these symbols may be utilized for that purpose. As previously stated, the graduations on the limit scale marked Hi and Hw respectively, indicate limits for inspection and working plug gages used for measuring standard holes. However, these fits can also be provided on other classes of work. The construction of the chart is somewhat unusual, as corresponding graduation spaces on the diameter and allowance scales are equal in length. For example, the space between the 1.5- and 2-inch graduations on the diameter scale is the same length as the space between the 0.0015- and 0.002-inch graduations on the allowance scale. A little study of the chart will show it to be a handy reference for draftsmen, as well as for shop men who often must rely on the cut-and-try method before a satisfactory tolerance is obtained.

* * *

The Federal Trade Commission has sent out questionnaires in order to determine the attitude of manufacturers in the iron and steel trade with regard to guarantees against price decline. About 250 replies have been received favoring the practice and about 150 opposing it. The Federal Trade Commission will hold a hearing on this subject in Washington, October 5.

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TRAINING VERSUS INSPECTION

Careful training of operators in the mechanical industries, instead of elaborate means of inspection, is one of the great needs of modern industry, in the opinion of Henry M. Leland, whose high standing and long experience in the automobile field give weight to his utterances. The waste due to lack of such training is appalling and counts heavily in the cost of production. It is the exception for men to be carefully instructed in regard to their work. They are left very much to their own resources, which may be meager enough. Great reliance is placed upon the inspection department, where the inaccuracies due to incapable, untrained workmanship are discovered, when they might have been largely prevented. With careful training of machine operators, the work of the inspection department could be materially reduced, in the opinion of Mr. Leland. There would be less spoiled work and fewer parts requiring remachining—all resulting in large savings in costs of production.

Inspection service will always be necessary in our highly organized industries, but the statement that inspection departments in modern factories are much larger than necessary, while preliminary training of the workers is neglected, comes with great force from a man of Mr. Leland's life-long practical experience in mechanical work. A little more attention paid to training would save a great many dollars now wasted, and, besides reducing the cost of the finished product, would improve its quality. Incidentally, it would reduce labor turnover, for the trained, responsible operator is worth more than the other kind, can earn more, and has greater respect for his job.

* * *

POTENTIAL AND COMMERCIAL VALUES OF NEW DEVELOPMENTS

Occasionally MACHINERY is asked for an opinion regarding the value of an invention or a new design of machine or tool. Perhaps an inventor has succeeded in originating some mechanical device that performs certain work satisfactorily; the question then arises: How much is it worth?

This question brings up the point often disregarded—that there is a vast difference between the *potential* and *commercial* values of mechanical developments, which is also true of commercial products in general. The organization back of a new type of tool or machine is such an essential factor that predictions regarding possible values are worthless unless the organization is considered. Well-planned selling campaigns often make a relatively inferior product of greater commercial value than a superior product lacking the support of a good selling organization.

Many inventors are so intent upon "making the thing work" that they give little or no thought to the commercial side of the inventing business, which is often as important as the actual development of the device itself. A machine may be very effective and have great potential value, but converting this value into cash is, after all, the most important and usually the most difficult part of the task.

After developing any mechanical device, it is necessary to consider, first, the cost of manufacture, which must not be out of proportion to the value of the machine as a producer. Many machines perform the work as the designer intended, but the real test comes when the prospective user compares the purchase price with the cash value of the output of the machine.

Besides this essential point, there is another matter of vital importance that inventors frequently overlook. A product, even though of great potential value to some large industry, has practically no commercial value until the possible users know of its existence. While this fact is obvious, it is evidently one of those simple axioms that are easily ignored. Then, too, when attempting to introduce a new machine or other device, it is necessary to overcome what has been called "human inertia," or that natural inclination to cling to the old in preference to the new, especially in the case of some mechanical development embodying a new principle. Here is where advertising and merchandising plans frequently increase the commercial value of a product out of all proportion to their cost. The man whose training has been entirely along technical lines, and especially inventors, often fail to realize that an invention—even though of exceptional merit—may not travel far on the road leading to commercial success unless it is impelled by good business methods, good advertising, and a resourceful sales force.

* * *

INTENSIVE USE OF FREIGHT CARS

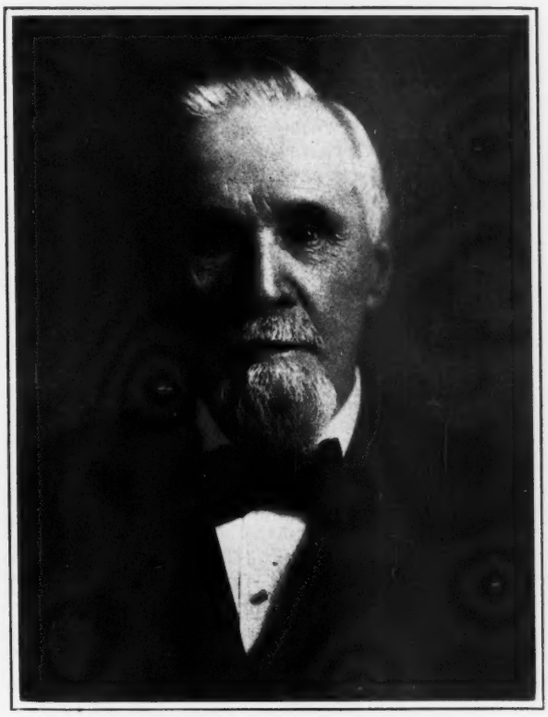
Statistics show that the railroads in the United States require an annual replenishment of 100,000 freight cars and 2500 locomotives, but during the past two years hardly 100,000 freight cars and less than 2000 locomotives were built, leaving a deficit of over 100,000 cars and 3000 locomotives for that period alone. This handicap of the railroads was seriously increased by the switchmen's strike in April, which made it impossible to load and unload cars with anything like normal dispatch.

An appeal is now made to shippers to cooperate with the railroads in assisting them to handle the large volume of freight that must be moved with inadequate facilities. It is pointed out that one of the most important ways in which this can be accomplished is by the speedier loading and unloading of freight cars, so that they may be kept constantly in service. For many years shippers, apparently, have not found demurrage charges sufficiently heavy to warrant making any special effort to avoid incurring them; but until such time as the railroads are able to replenish their rolling stock, promptness in loading and unloading cars is a vital consideration and demanded in the public interest. Failure to cooperate may result in regulations which the shipper will find more difficult than the voluntary effort to empty the cars quickly and keep them working. It is to be expected that the railroads will continue to make use of the economies in handling freight introduced during the war period and develop further economies along similar lines.

Amos Whitney—An Industrial Pioneer

AMOS WHITNEY, one of the founders of the Pratt & Whitney Co., Hartford, Conn., and long prominent as a manufacturer both in the machine tool field and in other lines, died at the Poland Spring House, Poland Springs, Maine, August 5, after an illness which lasted about four weeks. He was in his eighty-eighth year.

Amos Whitney was born in Biddeford, Maine, October 8, 1832. His early education was acquired in the common schools of Saccarappa, Maine, and Exeter, N. H. When he was fourteen years old, his parents moved to Lawrence, Mass., where he was apprenticed to the Essex Machine Co. During his apprenticeship period of three years, he worked on machinists' tools and locomotives, and after completing his apprenticeship, he stayed with the Essex Machine Co. another year as a journeyman, working on cotton machinery. In 1850 he went from Lawrence to Hartford, Conn., and worked in Colt's pistol factory, where his father was also employed, this factory at that time being generally known as Colt's Armory.



In 1852, Francis A. Pratt, later of the Pratt & Whitney Co., came to Hartford and entered the employ of Colonel Colt in his pistol factory. It was at this time that Amos Whitney and Francis Pratt first became acquainted, and when in 1854 Mr. Pratt became superintendent of the shop of George L. Lincoln & Co., afterward known as the Phoenix Iron Works, Mr. Whitney went with him. The two young men were closely associated, one as superintendent and the other as contractor, and remained with the Phoenix Iron Works until 1864; but in the meantime—in 1860—they rented a room on Potter St. and began doing some work on their own account, manufacturing a little machine known as a "spooler" for the Willimantic Linen Co., who owned a patent on this device for winding thread—the Conant patent. This was the beginning of the well-known Pratt & Whitney Co. of today. Both partners retained their positions with the Phoenix Iron Works and worked nights in their own shop. Shortly after their start, their shop was burned out, but a month later they were settled again for business in another location in Hartford. In 1863, they took into partnership Monroe Stannard of New Britain, Conn., each of the three partners contributing $1200. The association then formed remained unbroken until 1900. Mr. Stannard at first assumed charge of the shop, but the business so increased that in 1864 both Mr. Whitney and Mr. Pratt were obliged to give up their positions with the Phoenix Iron Works and devote their whole time to their own business. Incidentally it may be mentioned that it was about this time that Mr. Pratt designed the well-known type of milling machine known as the Lincoln miller.

In 1865 the partners erected their first building on the present site of the Pratt & Whitney Co., and from that time on the life of Mr. Whitney was identified with that of the Pratt & Whitney Co. until the business was sold to the Niles-Bement-Pond Co. in 1901. One of the chief products of the early firm was the Lincoln milling machine designed by Mr. Pratt. About 10,000 of these machines have been made and distributed by the company to all parts of the world. Beginning with the manufacture of a few machine tools, gun tools, and tools for the making of sewing machines, the Pratt & Whitney Co. gradually extended its lines until it built a great many types of standard and special machine tools. The invention of the typewriter and bicycle materially increased the demand for special machinery and tools, and Mr. Whitney was active in the direction of the company's affairs during the great period of expansion that followed the development of these new industries. Up to the spring of 1898 Mr. Whitney was superintendent of the works, and after 1893 vice-president. In March, 1898, he became president. From the organization of the firm in 1860 until 1893 Mr. Whitney never had more than three or four days vacation in the course of any one year, and he always, up to 1901, when he ceased to take an active part in the management of the business, except as a director, kept in close touch with his men.

In addition to his position as superintendent, Mr. Whitney was also the principal salesman of the plant, and his ability to sell machinery and tools was no less remarkable than his ability to keep in contact with the work in the shop while absent. On his return from business trips varying from two to eight weeks, he seemed to know just how the work in the shop had progressed, and could take up the broken thread as if he had been continuously in the shop. For a period of thirty years he traveled about one-third of the time, visiting large and small factories throughout the principal manufacturing districts in the United States. His acquaintance was very large among owners of shops, superintendents, and foremen, and he enjoyed an enviable reputation for good judgment and reliability. He was often called upon to give advice with regard to machinery for increasing production and reducing costs, and many of the orders that he filled proved of the greatest benefit to his customers. In some instances he was given a free hand to go ahead and build the needed machinery for a plant on his own responsibility. Work of this kind naturally led to the building of a great variety of machinery, much of which was of a special nature.

Mr. Whitney's policy in regard to visiting mechanics was a liberal one. Those who desired the privilege of going through the shop were rarely refused. In fact, he often gave his own time to showing them around and explaining the machinery and methods of manufacture. Needless to say, this was advertising of a most valuable kind, for in later years some of these men came to occupy positions of responsibility, and the methods that they had seen used in

the manufacture of the Pratt & Whitney Co.'s machines often induced them to purchase from that concern.

In 1896 the Whitney Mfg. Co. of Hartford, Conn., was organized by Clarence E. Whitney, a son of Amos Whitney, Charles S. Whiting, and Arthur L. Shipman. In 1901 the controlling interest in this firm was acquired by Amos Whitney and Clarence E. Whitney. The former has been a director of this company since 1900 and secretary and treasurer since 1902. He was also a director of the Pratt & Whitney Co., and of the Hartford Faience Co., and president of the Gray Telephone Pay Station Co.

Mr. Whitney married, in 1856, Miss Laura Johnson of Hartford, Conn. They had two daughters, Nellie Hortense, who died in childhood, and Nettie Louise, who survives him, and one son, Clarence Edgar, who is now president of the Whitney Mfg. Co. Amos Whitney and his wife celebrated the fiftieth anniversary of their wedding in 1906, at which time more than one thousand people attended the reception given by them at their residence.

In spite of his advanced age, Mr. Whitney continued to fill an active and important place in the industrial life of Hartford until his death. He was always an indefatigable worker, and he ascribed his unusual vigor for his age to this fact. Throughout all the years of his business life he kept in close touch with his men, and they all felt a strong allegiance to him. He was always straightforward in his dealings with them, and as one of his old men said, "whatever he promised he would do." He was easily foremost among the representative self-made men of Hartford, and the city owes much of its material prosperity directly to his efforts.

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COOPERATIVE MECHANICAL HIGH-SCHOOL COURSE

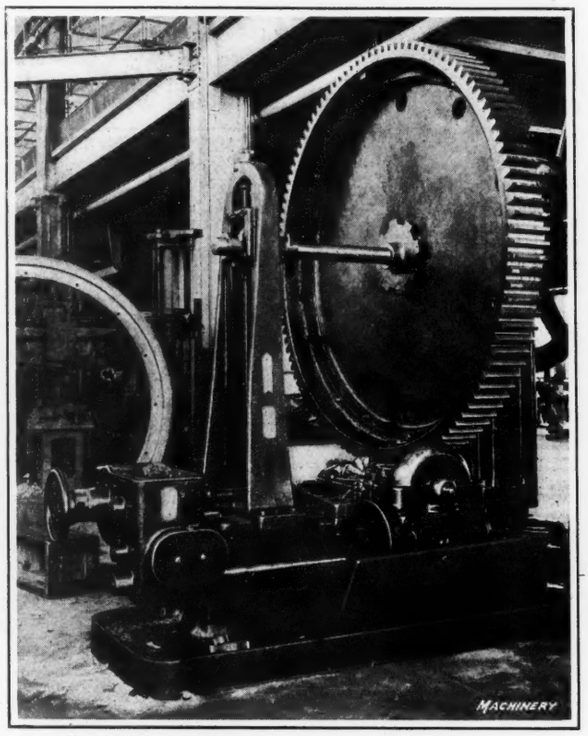
Cooperative high-school courses have been in operation in Springfield, Vt., for several years, the high schools cooperating with the local manufacturing companies. A total of forty-four boys are now taking this course, working part of the time in the shops and part of the time in the high school. The course alternates with two weeks of practical work and two weeks of school work, and in addition the boy works full time in the shop during the school vacations, except that he is allowed a vacation of two weeks. The present rates of pay in the shops are 20 cents per hour for the first year, 25 cents for the second year, and 32 cents for the third year, in addition to a special bonus which is paid to the students upon graduation. For those beginning the course this summer, this bonus will amount to $180. Altogether, in the three years' duration of the course, the boy will earn about $1400.

The shop work includes complete instruction and training in all the ordinary shop departments, and the school work instruction in drawing, mathematics, the theoretical side of shop practice, physics, chemistry, theoretical mechanics, etc. Instruction is also given in English and history. Students are accepted from localities other than Springfield, and a number of boys come to the school from the most distant parts of the state, and even from other states. The graduates are accepted without examination and with full standing in the engineering courses given by the University of Vermont, the University of Cincinnati, the Worcester Polytechnic Institute, the Norwich University, and the Northeastern College of Boston. John M. Pierce, director of the cooperative work in the Springfield high school, in reviewing this work in *The Vocational Summary* states that there has been a remarkable spirit of cooperation between the managements of the different plants and the school authorities, and that foremen and superintendents have been lending active assistance toward the success of the plan.

To enter the course, the same requirements are made as for entrance in the regular high-school course, and the course provides an opportunity for boys with limited means to obtain the equivalent of a high-school education.

CUTTING THE TEETH IN A LARGE GEAR

The accompanying illustration shows an old-style Gould & Eberhardt gear-cutting machine engaged in cutting the teeth in a large lathe faceplate gear at the Putnam Machine Works, Fitchburg, Mass. This operation is of interest from the fact that the job requires the machine to be set at very nearly its maximum capacity and that the work is performed with excellent results, both regarding quality and rapidity. The gears are cast from steel having the following analysis: Carbon, 0.25 to 0.35 per cent; manganese, 0.60 to 0.80 per cent; silicon, 0.15 to 0.30 per cent; phosphorus and sulphur, not over 0.05 per cent. These steel blanks are annealed and the teeth are then cut with a roughing and a finishing cutter. The teeth are of the 20-degree involute form, and the gear is of 88-inch pitch diameter, and has 110 teeth of 1¼



Gould & Eberhardt Old-style Gear-cutting Machine engaged in cutting Teeth in Large Gear

inches diametral pitch. The face of the gear is 7½ inches, and the time required to rough- and finish-cut the teeth is twenty-six hours, which is considered a satisfactory production rate.

* * *

STEEL TREATERS' SOCIETY CONVENTION

The American Steel Treaters' Society and the Steel Treating Research Society who will hold their annual joint convention in Philadelphia, September 14 to 18, at the Commercial Museum, 34th and Spruce Sts., have arranged for an extensive program and for the reading of a great many papers of importance in the steel-treating field. In addition to the convention program, a very extensive exhibition will be held. The exhibition will open Tuesday, September 14 at 9 A. M. and will be kept open during Tuesday and Wednesday, September 14 and 15, until 10:30 P. M., while on Thursday and Friday, September 16 and 17, it will close at 5 P. M. Saturday, September 18, the exhibition will be open from 9 A. M. to 6 P. M. Over 80,000 square feet of floor space will be used to display heat-treating appliances and heat-treating products, and over 125 firms will exhibit. The exhibitors will represent the leaders in their line and include firms of national reputation. On Friday, September 17, there will be no sessions, but instead a number of plants in Philadelphia and vicinity will be visited.

The German Machine Tool Industry

From MACHINERY'S Special Correspondent

Berlin, August 6, 1920

THE past year has been a difficult one in the German metal-working industries. Repeatedly there has been evidence of improvement in the industrial and economic situation and then unexpected events have scattered the hopes. It has been a time of uncertainty and of internal political disturbances, and much time has been lost in the rehabilitation of the industries by endless and aimless discussion. The result of it all has been that at the end of 1919 the situation seemed to grow more and more difficult. In spite of all these difficulties, the Association of German Machine Tool Builders prepared for two exhibitions of machine tools, one of which has already been held at Leipzig, demonstrating that the machine tool industry in Germany is still active.

Increase in Manufacturing Costs

The three items, wages, cost of raw materials, and overhead expenses have increased to a considerable degree during the past year, and the prices of machine tools have been increased in proportion. Labor unrest, with numberless strikes, has harassed the machine tool industry. In the beginning of 1919 the manufacturing costs had advanced to three times those in peace time, but at the end of 1919 the manufacturing costs were from eight to nine times what they were previous to the war. Hence, during 1919, both costs and selling prices increased about three times, or 300 per cent. Many firms suffered heavy losses on account of the rapid changes in business conditions. The home market was not active, as buyers were of the opinion that the high prices could not be kept up perpetually, and recognized that an investment in machine tools at eight or nine times the peace-time price would be a dangerous experiment. Hence, business has steadily decreased in spite of the fact that a demand for machine tools would exist provided the price were more nearly normal.

The Foreign Trade in Machine Tools

Early in 1919 the Board of the Association of German Machine Tool Builders suspended the price control rule which had governed the foreign trade of the members, it being the opinion that this was necessary in order to meet the competition of America and England. By giving the German trade a free hand in this way, it was believed that the interest of the members of the association would be served in the best manner. The sale of machine tools abroad assumed huge proportions, but the price obtained in foreign currency was only a fraction of the price obtained for machine tools manufactured in other countries, due to the depreciation of the German mark. This led to a new control of export prices, which took effect on October 7, 1919. From that time on, reasonable selling prices in the foreign trade have been maintained. The large exports in 1919 are considered in Germany as a life-saver for the German machine tool industry, as this export trade compensated for the decreasing home demand.

These conditions no longer exist in the present year. The output of the German machine tool industries since 1914 has increased considerably, and while there is a great demand for machine tools in all parts of the world, American competition is beginning to be felt and German machine tool builders must be able to decrease their costs, which can only be done by reductions in the costs of raw materials and wages. It has been pointed out that in order for Germany to hold its own in competition with England and America, the claims of labor in Germany must be modified, that the German selling organizations of the past must again be built up to at least equal those of America and England, and that manufacturers in Germany must learn once more to be content with the profit which they formerly considered sufficient.

The export of twist drills and other metal-working tools, as well as of precision measuring instruments, assumed large proportions during the past year. At present the export prices on metal saws, chucks, and grinding wheels are controlled, and the prices of other accessories and tools will be controlled at an early date.

Association of German Machine Tool Builders

The Association of German Machine Tool Builders has been active in organizing the whole German machine tool and accessories industry. The industry has been divided into a number of groups, each group being the complete master of its own interests and having complete control of the studies of the home and foreign markets, by which it is proposed to prepare for the severe times which the industry must pass through. In numerous cases conferences between manufacturers making competitive lines have led to a friendly understanding as regards both methods of manufacture and selling policies for certain classes of machines. This cooperation is one of the most valuable results of the work of the association during 1919. The number of members of the machine tool builders' association and the associated industries are as follows: Association of German Machine Tool Builders, 363; Association of German Precision Tool Builders, 108; Association of German Woodworking Machinery Builders, 75; Association of German Manufacturers of Grinding Wheels, 34; Association of German Manufacturers of Twist Drills, 20; and of the Society for Research, 73.

* * *

CHARLES PARSONS AWARDED FRANKLIN MEDAL

The Franklin Institute this year awarded the Franklin medal to Sir Charles Parsons, "in recognition of his epoch-making success in the development and construction of the steam turbine, which has revolutionized the art of steam engineering, particularly in regard to the propulsion of mercantile and naval vessels, and the driving of electrical generators." Like that of all pioneers, his path was at first one of difficulties and discouragements. For years it was impossible to make engineers in general accept the steam turbine seriously, and Mr. Parsons separated from his original partners because they became too discouraged to proceed further with the development work. Mr. Parsons, however, did not become discouraged, but overcame each mechanical and commercial difficulty as it arose, and established certain principles of design which are now followed and accepted wherever steam turbines are built. *Engineering*, of London, says that there is no exaggeration in the statement that the work of Sir Charles Parsons has cut in half the cost of producing electric power and reduced in still greater proportion the original cost of power generating machinery. The problem solved was one of unusual difficulty, since the steam turbine is essentially a machine which must be built in big units in order to show its full efficiency, and is at a disadvantage when built in small sizes. Yet, until Mr. Parsons made good with the smaller sizes, there was, of course, no demand for larger units; hence he was forced to make a success of the design of the machine even in its most disadvantageous form.

Why the Westinghouse Company Does Not Use the Metric System

In view of the discussion on the metric system that has been caused by the activities of the advocates of laws making the system compulsory in the United States, the present article, prepared by the Westinghouse Electric & Mfg. Co., stating the company's position in regard to the metric system will prove of interest and value. This opinion from one of the largest manufacturing concerns in the United States enumerates briefly the company's chief objections to the metric system.

IT is sometimes difficult to explain the obvious, all the more so when reasons for the explanation appear unnecessary as well as approaching monotonous repetition. This is doubly true of the case against the adoption of the metric system, whose use, pro and con, has been expounded in all sections of the United States since the early part of the nineteenth century. At first, suggestions were quietly put forth regarding its supposedly simple characteristics. During the last few years, propaganda urging its general adoption has grown more aggressive, until now the mails are filled with metric literature. Bills have even been introduced in Congress whose passage would have meant that the use of any system of weights and measures other than the metric system would have been illegal.

In spite of all this urging there appears to be no general demand for the adoption of the metric system in this country. The manufacturing plants that are using it are few in number, while the great mass of people who are responsible alone for a system of weights and measures are scarcely aware of its existence. This cannot be attributed to ignorance, for it is taught in all public schools, and the statutes of the country legalized its use many years ago. If it has so many desired characteristics it would seem to the layman that the process of simplifying weights and measures was very slow.

One of the reasons most commonly urged for the adoption of metric units is that it would greatly aid foreign trade. That would appear to be inviting the mountain to go to Mahomet, for the greater number of manufacturing plants are located in English-speaking countries, where naturally the people use only the British system of weights and measures. Factories located in the United States, for instance, sell all but a small percentage of their goods in this country. It would appear, then, that to sell a few articles to metric countries, a certain class would make one hundred million people climb out of their accustomed channels to learn a puzzling unfamiliar language. Nor is this necessary, for the Westinghouse Electric & Mfg. Co. does a great deal of business with countries using the metric system without difficulty or embarrassment.

From stories sent out it would seem that all foreign countries with the exception of Great Britain were metric. This is not true. In Latin America, some countries use a system of English extraction but with Spanish terms; some use metric and Spanish; others use metric alone, but they are all familiar with the English system.

No one doubts for a moment the tremendous difficulties that would be involved in making this country over into a metric speaking and thinking people. These difficulties would multiply daily until nothing less than chaos would result. First, the greatest number of people in the country would have to learn the metric tables. Then they would have to translate metric terms into English before a ratio of values could be obtained. This, in daily life, where thousands of small transactions are carried on would be difficult.

This is a period when production is needed, there being shortage of manufactured materials throughout the country. Is there any reason for urging the adoption of the metric system at this time when it is certain that, were it suddenly introduced in the factory, production undoubtedly would be held up until the workmen familiarized themselves with the new units? The very fact that English measurements can be halved and quartered without introducing complicating fractions makes it more advantageous in shop work than the metric measurements.

A case in which metric measurements complicate shop work has been recently acknowledged by an official of one of the largest tire companies in the world. His company recently adopted the metric system, and it is now partially used in all except the most recent factory, which is all metric. His words regarding the advantages of the system are interesting, particularly in regard to its use in the storekeeping and shipping departments. In the former, raw materials received in English units must be transferred into metric units by production clerks before going to the workmen. Upon completion, the metric article must again be converted into the English units, in order to mark shipping weights. There are some departments of that company which are still using the English system—more translation. This condition, the writer says will last until the United States adopts the metric system. Judging from past experience there will be a long wait.

The Westinghouse Electric & Mfg. Co. has no desire to install a metric translation department pending the adoption of the French system in America. It is a complex organization, highly detailed, and a delay in any point of production, is felt in every department. Thousands of delicate, high-priced instruments are in daily use which the company has no desire to scrap for metric tools. There are also many tables computed in the English system which would have to be made over and in addition it would be necessary to have a table of equivalents, practically tripling the labor used in making up tables, as well as doubling their size. This paves the way for errors. This company, too, has little desire to install a school to teach its thousands of workmen the metric system. The work entailed in this one item alone would be enormous, even if it were certain that employes could pick up the system rapidly.

These are, briefly, some of the reasons why the Westinghouse Electric & Mfg. Co. is opposing the introduction of the metric system in America. Its advantages have yet to be proved in every way, except theoretically, and its practicability in the United States is uncertain.

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BRITISH ENGINEERING STANDARDS ASSOCIATION

The British Engineering Standards Association held its second annual meeting in London July 15. This association is rendering a valuable service in coordinating standards, promoting efficiency, and eliminating waste. The association has been at work for nearly twenty years, and has now thirty committees with over 1400 members who give their time and experience, often at great personal expense and inconvenience, to this standardization work. At the present time the association is working on standards for copper alloys, steel wire ropes, milling cutters and reamers, and many other classes of products outside of the metal-working field.

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, August 12

THE machine tool industry in Great Britain is rapidly reaching more normal conditions, although this does not mean normal as judged by the old standards. After the remarkable demand of the last few years, the importance of any falling off in inquiries and orders is apt to be exaggerated. Many users and dealers still complain of the shortage of really high-class machine tools, and the complaints go further, the statement being made that some of the imported machine tools that rightly gained a reputation for accuracy in the years before the war now often show unreliability in this respect.

Market in Used Machine Tools

Sales by auction of machine tools used in munition factories are still proceeding. In some respects, this source of supply has been a very useful feature in connection with the reconstruction work that has been going ahead in most engineering works, in so much that tools from this source represent immediate delivery—an all-important point. When these tools began to come before public notice, some of the most reputable machine tool makers and merchants realized that the large quantities to be offered opened up enormous possibilities. Consequently they bought up stocks of the tools at reasonable prices, transferred them to their own works, and subjected them to a thorough and complete overhauling, effected repairs where necessary, and finally offered them as rebuilt machine tools in first-class working order at competitive prices.

General Situation in Machine Tool Industry

Several large districts report a distinct lull in the inquiries for new machines, and there is no doubt that high prices have recently been a contributory factor. The partial decontrol of coal should before long have a good effect on the machine tool trade, since the immediate result of decontrol has been the placing of important contracts for the extension of mine properties adjacent to the large machine tool centers. Another factor is that the disorganization in the casting supply due to the great strike is gradually being rectified; in fact, some firms in the Birmingham and Coventry districts have reached the stage of being able to quote immediate delivery of castings.

The most striking feature in the industry is to be noted in the large number of machine tool firms who are reducing the number of models made, concentration on a minimum of varieties being substituted for the pre-war tendency on the part of many firms to undertake any type of tool for which an inquiry was received. This change will be exemplified at the forthcoming Machine Tool and Engineering Exhibition to be held at Olympia, London in September, for which the majority of firms are developing new machines that will then be seen for the first time.

In the engineering establishments on the Clyde, business, especially in shipbuilding, remains good, although here too the falling off in demand for machine tools is seen, the heavy tool trade being most affected in this district. International and colonial trade shows no such wavering; exports of machine tools are continuing to rise, and for the month of May a value of over £280,000 was sent out of the country. Colonial requirements of small tools, particularly in Australia and India, are growing to large proportions. Imports into Great Britain show a falling tendency; this condition has been expected. At the same time Switzerland has been recently sending over some very highly developed machine tools among which are some automatic thread-chasing lathes of the precision class. Sweden also is endeavoring to get a good footing here, but with tools of the heavier type. Small Austrian 12-inch lathes have also made their appearance.

In the letter relating to the British machine tool industry in the May number of MACHINERY, page 890, a statement was made relating to the increased trade in machine tools for which Sweden is laying the foundation in the English market through its selling organization—the Swedish Machine Tool Makers Export Co., Ltd. Unfortunately this statement was made in the same paragraph that referred to a definition of the term "dumping" as related to the importation of goods. The fact that these two statements appeared in the same paragraph might give the impression that the Swedish export company referred to is dumping machines on the British market. This impression should be corrected; it was not intended to convey this meaning, as it is not in accordance with the facts. The Swedish Machine Tool Makers Export Co. is not competing in the cheaper machine tool market, but handles machines of a class and at a price competing on an even basis in the best British machine tool market.

Labor Conditions

Labor leaders here have for some time realized the peril of forcing up wages far beyond an economic figure, and there is now some evidence that they have succeeded in making this fact appreciated by the rank and file. In some engineering industries, works have been shut down, although not in the machine tool trade. New claims for large increases in wages in the shipbuilding and engineering trades have recently been before the Industrial Court. At the same time manufacturers are insisting that unless means can be found of arresting the increasing cost of production, widespread unemployment is inevitable. Payment by results is already in force in many iron foundries, and the Midlands show some excellent examples of its effects.

The wrought-iron industry in England has been considerably hampered during the last few years through lack of men, particularly puddlers. Staffordshire is the principal seat of the wrought-iron industry, there being from 600 to 700 puddling furnaces in the district, all operated by hand. These furnaces have a total capacity of over half a million tons of puddled bars per year, and in the past used to employ 10,000 men; but even before the war there was the difficulty of obtaining the required number of men. When the war began, this shortage was accentuated by the rush of men to the colors. Experiments in mechanical puddling have never been viewed with much favor in England, and the results achieved have been unable to overcome the prejudice against it. It has become necessary, however, during the past year, to experiment with a new system of mechanical puddling in order to overcome the condition existing through lack of experienced puddlers. As England has furnished the world with its principal supply of high-grade wrought iron, any curtailment of this industry would be serious, both from the British point of view and from that of other nations who have obtained the wrought iron now used mainly from British or Swedish sources.

On the outbreak of the war, the British Government hurriedly bought up the whole available supply of Swedish iron in Sweden and shipped it to England to prevent its falling

into the hands of the enemy. The large stocks then formed are now being broken up, and in the present scarcity this iron has proved a valuable source of auxiliary supply to the Sheffield steel makers. Castings are still in very strong demand in most districts, and manufacturers who do not operate their own foundries are still buying without counting the cost; consequently prices are very irregular.

A recent report by the Ministry of Labor on profit-sharing schemes does not show the various experiments that have been made in a favorable light. The average life of these experiments seems to be about fourteen years, abandonment frequently being caused by the inability of the firm to earn regularly the necessary profits required to make profit-sharing a success.

New Developments in the Industries

From all quarters news comes of extensive developments in all branches of the machine and small tool industries. Nearly all firms of importance are increasing their capacity, and many new companies have been formed. In Birmingham a new tool steel is being developed which it is intended shall fill the wide gap between carbon and high-speed steels. It can be used up to a temperature of from 1100 to 1300 degrees F., and the steel can be produced to sell at about 50 per cent above carbon steel and 30 per cent below tungsten steel. It is also suitable for ball races. In the Glasgow district new foundries are being erected. J. Rhodes & Sons, the large makers of power presses in the Wakefield district, have increased their ground space by twelve acres, on which a new works for the manufacture of power presses and similar tools will be erected. They also have in hand world-wide orders for press plants for the manufacture of paint drums and petroleum cans. In Coventry, Alfred Herbert, Ltd., is adding ten 30 by 200 feet bays to their Edgwick works; these will be devoted to the increasing manufacture of large combination turret lathes.

At the present time it is computed that only three and one-half million is being used out of a possible sixty million horsepower available from water power in the British Empire. W. G. Armstrong Whitworth & Co., Ltd., are now undertaking the manufacture of water turbines at Glasgow, in anticipation of a larger use of this natural power.

New Machine Tools

It is not possible to indicate many details of the numerous new designs of machine tools that are undergoing development, as in most cases the forthcoming Olympic exhibition is the goal for which these are being prepared. Many new machines have appeared within the last few weeks, however, and a few of the more important can be mentioned. One of these uses an entirely novel method of screw production, in that the screw thread is generated by a rotating cutter whose axis is substantially at right angles to that of the rotating work. Striking claims are made for the output capacity of the machine, but it is not yet possible to give further details. A number of heavy-duty railway wheel lathes have just been completed by Loudon Bros., Ltd., Johnstone, Glasgow. On test, one of these machines turned a pair of 5-foot brake hardened driving wheels in thirty-six minutes. A new automatic power sheet press has been completed by J. Rhodes & Sons, Wakefield. The press is capable of making up to 100 stampings per minute, and a good saving of material is effected, since it can be set to stamp in staggered positions, thus cutting down waste to an absolute minimum. By stamping direct from the sheet, it also saves preparatory shearing of the metal into strip form, and one operator can easily run two machines. Clifton & Waddell of Johnstone, Glasgow, has developed a horizontal disk sawing machine with a saw, 5 feet 6 inches in diameter, mounted directly on the armature shaft of the motor. The saddle carrying the motor and the saw is traversed along the bed by a small auxiliary motor. The main motor is of 40 horsepower, and the capacity of the machine is up to 24- by 7½-inch sectors. T. Atkinson, Ltd., Accrington, have a new toolroom lathe of 4¼-inch centers. An interesting feature in the manufacture is the fact that no planing is used, milling operations being substituted.

Milton, Ltd., of Streathan, London, is making a relieving attachment that is a radical departure from all existing methods. The cutting tools are carried in rocking arms, the relieving effect being obtained from a toothed wheel having the same number of teeth as the cutter to be relieved. The amount of relief is variable while the machine is running, and the work is carried out at approximately ordinary turning speed; in fact, for light finishing cuts such as are required to produce a relieved land the tool can be reciprocated 1000 times a minute. The Lumsden Machine Co., Ltd., Gateshead-on-Tyne is developing a new line of vertical surface grinders for a 60- and a 24-inch diameter wheel, while a horizontal machine is to have a 30-inch wheel.

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DeLAMATER-ERICSSON MEMORIAL TABLETS

At the annual convention of the American Society of Mechanical Engineers last December, a memorial meeting was held on the evening of December 3 in commemoration of the eightieth anniversary of the arrival in the United States of Captain John Ericsson and his fifty years association with Cornelius H. DeLamater in engineering work. In advance of the meeting it had been decided to erect memorial tablets to mark the sites of certain buildings which were closely identified with the work of DeLamater and Ericsson. It was proposed to erect four tablets as follows: One at the Phoenix Foundry at Laight and West Sts., where the first screw-propelled vessel in this country was constructed and where many other original developments were made; one at Captain Ericsson's residence, 26 Beach St., where he designed the *Monitor* and made all his inventions during his later years; one at the DeLamater Iron Works at the foot of W. 13th St., where the engines of the monitors *Puritan* and *Dictator* were built, as well as the first submarine boat, the first torpedo boat, the first torpedo boat destroyer, the first self-propelled torpedo, the first air compressors, the first ice machines, and many other industrial appliances now in general use; and one at the Continental Iron Works, Greenpoint, L. I., where the hulls of the *Monitor* and other warships were built.

It is believed that there are many marine and industrial firms, organizations and individual manufacturers and engineers who, if given an opportunity, would contribute to the tablet fund, especially to commemorate the invention of the screw propeller and the building of the *Monitor*. Those interested are requested to communicate with the DeLamater-Ericsson Tablet Committee, H. F. J. Porter, chairman, Room 1100, Engineering Societies Bldg., 29 W. 39th St., New York City.

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AMERICAN FOREIGN TRADE FLOATING EXPOSITION

It has been announced that the first national foreign trade floating exposition will sail from the United States for South America and the Far East in October. The vessel will contain exhibits of American manufactures, the purpose being to improve trade relations with the countries visited and reduce the expenses incident to trade promotion by each individual manufacturer. Various lines of manufactures will be represented, but only one manufacturer in each competing field will have an exhibit. The ship will stop at the various ports for a period of from five days to two weeks. Interpreters will be placed on board, and a publicity man will precede the exhibition, making proper announcements. The trip, as planned, will last eight months, and all the important Central and South American ports will be visited, in addition to New Zealand, British Straits Settlement, Australia, the Philippine Islands, China, and Japan. The exposition offices are at 50 Church St., New York City.

DIES FOR SHAPING AN AUTOMOBILE BODY PANEL

By J. BINGHAM

The construction and operation of three forming dies used in the production of metal panels which are assembled on the framework that supports the seat of an automobile are described in the following article. The first operation consists of trimming to size the rectangular piece of sheet steel from which the panel is formed, and this is done on a shearing machine. The die used in the first shaping operation on the blank is illustrated in Fig. 1, which shows the appearance of the work and the positions of the various parts at the end of the downward movement of the press ram. Prior to the downward stroke, blank-holder *A* is in a raised position, the highest surface of the steel inserted piece *B* being in the same plane as surface *X* of die-block *C*. Piece *B* is brought to this position by means of pins *D* which are actuated by a rubber buffer attachment.

In the operation of this die, the blank is placed across the die opening, one end resting on surface *X* of die-block *C*, against the locating strip *E*, and the other end resting on point *Y* of the die-block. Then as punch *F* descends on the downward stroke of the press ram, the blank is gripped be-

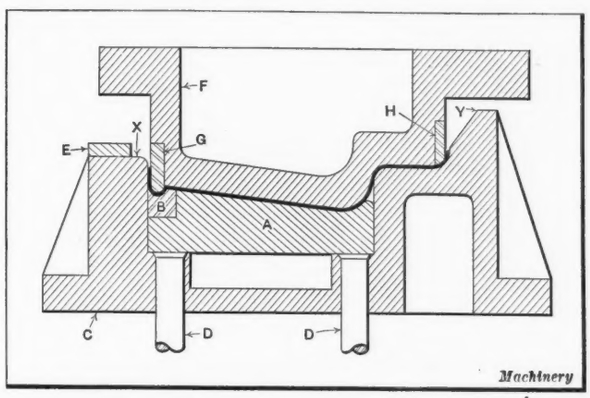


Fig. 1. Die employed for the First Forming Operation on a Rectangular Shaped Blank

tween the surfaces of the punch and of blank-holder *A*, and as they descend together, the blank is formed to the shape of the punch and die parts. The panel is ejected from the die after the completion of the operation by the blank-holder as it returns to its original position by the arrangement previously described. There is no tendency for the blank to adhere to the punch on its return stroke, and so no means are provided for its removal. Blank-holder *A*, die-block *C*, and punch *F* are made of cast iron, which is a suitable material for dies of this type where the bends produced on the work have a comparatively large radius. Punch *F* is provided with two steel faces *G* and *H*, and blank-holder *A* is provided with a steel inserted piece *B* for producing the small bends at the ends of the panel. Die-holder *C* and punch *F* have large cored openings at suitable places in order to lighten their weight.

The next operation on the panel is performed by the die shown in Fig. 2, and consists of bending surface *X* of the work at right angles with surface *Y*. The upper surface of blank-holder *A* is of the same contour as that of a portion of the work as it comes from the preceding operation, thus serving to locate the work properly for the operation to be performed by this die. The blank-holder is in a raised position when punch *B* is lifted from the die, and so it is possible for surface *X* to rest upon the slanting surface of die-block *C* prior to the shaping operation. The blank-holder is raised to the proper height by means of springs, which are not shown in the illustration. The work is bent to shape as punch *B* descends on the downward stroke of the press and forces the work into the die, the work being held firmly between the punch and the blank-holder while the bending action is occurring. It will be noted that punch *B*

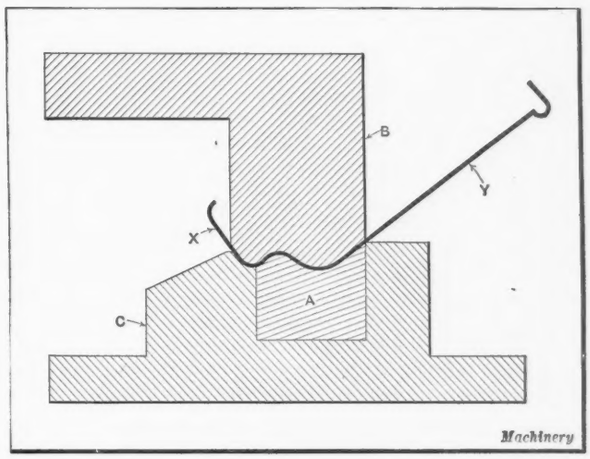


Fig. 2. Forming Die used to bend One End of the Work at Right Angles to One of its Other Surfaces

is offset, so that there is no interference between the work and the front of the press during the operation. All the illustrated parts of the die are made of cast iron.

The third and final operation on the panel is performed by the die shown in Fig. 3. This consists of bending surface *X* once more, the illustration showing the appearance of the work and the position of the various moving parts at the end of the downward stroke of punch *A*. Blank-holder *B* is in a raised position prior to the downward stroke so as to permit the panel to be seated on the blank-holder with surface *X* of the work resting upon the upper surfaces of part *C* and die-block *D*. The raising of blank-holder *B* is accomplished by means of springs, which also permit it to eject the work from the die at the end of the operation. Punch *A* is offset for the same reason as the punch in the preceding operation. It is made of cast iron, but is provided with a tool-steel inserted piece *E*, because cast iron would not be sufficiently strong to sustain the stress produced in the peculiar shaped forming portion of the punch which provides clearance for the curved end of the work. The inserted die part *C* is also made of tool steel and is held to die-block *D* by machine screws. Blank-holder *B* and die-block *D* are also made of cast iron.

* * *

Due to the shortage of coal in France, oil-burning locomotives have been introduced on the French railroads. Two advantages have been gained by the use of oil: It has been found that time can be saved in getting up steam and that an engineer alone, without a fireman, is able to man a locomotive, thereby saving labor, which is one of the prime necessities in France at this time.

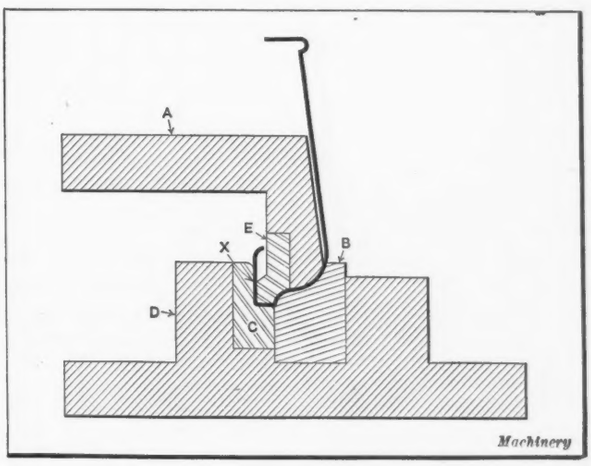


Fig. 3. Die with Offset Punch used in the Final Shaping Operation on the Automobile Body Panel

Training Future Mechanics

Methods Employed by the R. K. LeBlond Machine Tool Co., in Educating Future Mechanics in an Apprenticeship School where One Hundred and Fifty Boys Receive their Mechanical Training

By ERIK OBERG

AMERICAN machine tool manufacturers appear to be more aware than ever of the necessity of training skilled mechanics by the apprenticeship method. Conditions during the war, and perhaps even more so since the war, have made it apparent that the supply of skilled mechanics is strictly limited, and that while machine operators can easily be obtained, the all-around machinist and toolmaker is becoming more and more scarce. The only way in which this condition can be improved and the future supremacy of the machine industries insured, is by systematic and careful training of young men duly apprenticed for a specified training course.

It is recognized that the old-fashioned apprenticeship where the boy was merely taken into a shop and passed from foreman to foreman, picking up what training he could according to the ability and inclination of the foreman of each department to impart knowledge to him, no longer meets either the requirements of the industries or of the boy himself. The young men of today are not satisfied to apprentice themselves if they are not assured of a better training than can be obtained in this manner; and the American industries of the future require men better trained than would be possible if this old system of apprenticeship were used.

General Principles of LeBlond Apprenticeship School

The R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has developed an apprentice system which combines the best features of the old-time apprenticeship with the best features of the modern trade school. The boys not only receive theoretical instruction in an actual school, but they also receive their preliminary shop instruction in a special training shop conducted for this purpose alone, and are not placed in the actual shop departments until they have received such preliminary training in the operations of the machines as will insure that they will be able to handle the work without too much personal instruction from the foreman. Hence, a boy entering this apprenticeship system receives his education and training in three separate departments: The school-room, where he is given instruction in mathematics and drawing, so that he may be able to perform any ordinary shop calculations and read blueprints readily; the training shop, where he is given preliminary training in the use of all standard machine tools; and the factory, where he serves the major part of his apprenticeship and becomes thoroughly familiar with modern manufacturing methods.

For years American manufacturers have been so busy increasing plant facilities, devising more efficient means of production, and designing and building new machinery and tools, that but little attention has been given to the training of all-around mechanics, fitted to become the future mechanical executives and leaders in the machine building industries. The old-fashioned type of apprenticeship has broken down, and few manufacturers have provided anything to take its place. Recently, however, there has been a general recognition of the fact that the future supremacy of American machine industries depends upon the systematic and careful training of the men who are to become the skilled mechanics, foremen, and superintendents in our shops ten, twenty, and thirty years hence.

Selecting Boys for Apprenticeship

One of the features characterizing this well-planned apprentice school is the care taken to select the right kind of boys for training. Cincinnati being pre-eminently a machine manufacturing city, it is perhaps easier to interest a sufficient number of boys in becoming skilled mechanics than would be the case in other cities. At any rate, there is a sufficient supply of bright, intelligent, well-educated boys to draw upon to make it possible to carefully select those best fitted for the apprenticeship course. Preference is given to boys having a high-school or equivalent education, although grammar school graduates with a good school record are also accepted. The course is four years for grammar school graduates and for those who have not completed a high-school course. High-school graduates from accredited high schools serve an apprenticeship of three years only, while graduates of recognized technical schools serve two years only. This article deals only

with the apprenticeship course as far as it relates to high-school and grammar-school graduates. The boys must be between sixteen and twenty years of age when beginning the course.

Application for Apprenticeship Course, Interviews, and Examinations

The boys make application to enter the apprentice course to the regular employment manager, Carl Breeding, who interviews them and obtains as much information as possible relating to the boy by questioning him and by observation. The care exercised in selecting boys for the course is not limited to matters of education, but relates to many other conditions that have an influence upon the boy's fitness for the calling he has chosen. The application blank contains the usual information, giving the boy's name, date of interview, age, address, his father's name and occupation and where employed, the boy's previous education, and where and how long he has been at work, if previously employed elsewhere. It has been found of considerable importance to investigate the father's occupation and the general home conditions, as these have a considerable effect upon the boy's success. Generally speaking, the boys whose fathers are themselves engaged in mechanical pursuits are better satisfied and accomplish more than those who come from families in other walks of life.

An opinion of the boy's fitness for the work is also formed by observation, taking into account his general knowledge of things and his judgment. This is done by bringing up subjects in a conversational way about which the boy might be expected to be informed or upon which he could have formed a judgment. If he shows intelligence and ability of independent thought, it counts in his favor. The employment manager also tries to obtain some ideas as to his mental attitude in general and his opinion about the class of work that he will be doing in the shop. On each of the points brought up he marks him with a certain percentage and by adding these percentages together, a general grading of the boy is obtained, which gives quite an accurate estimate of his qualifications.

The interview with the employment manager does not by itself determine the boy's eligibility for the course, but he is next sent to the classroom instructor, O. Martens, who examines him in mathematics and who also, if deemed necessary, obtains his school record and rating, thereby checking up the boy's statements, and visits his home. After the boy has been approved by both the employment manager and the classroom instructor, he is admitted to the course, but is first accepted for a three months' probation period only, the same as in most apprenticeship courses.

The Training Shop for Apprentices

When reporting for work, the boy is first placed in the training shop, which is a separate department in charge of the instructor, Robert Buckton, and the assistant instructor, B. Konnerman. The first week in the training shop is devoted chiefly to teaching the use of measuring instruments, scales, micrometers, verniers, etc. The boy is also taught the names and purposes of the more common tools used in the shop, such as dogs, mandrels, reamers, drills, taps, milling cutters, standard gages, etc. Having obtained a general idea about these matters, he is given some simple machine work. It has been found that different boys show considerable difference in aptitude in the operation of different machine tools, and that some boys will do much better if they are started, say, on a milling machine, while others will do better on a lathe. By trial, the type of machine tool that the boy likes the best is determined, and he is given his first training on this type of machine. He will remain at this machine for the rest of his stay in the school shop, which varies from two to six weeks, according to the ability of the boy. From the school shop he will then be transferred to that department in the shop for which he has been trained in the school shop, so that, if he has received training on a milling machine, he will be

The R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has developed a system of training that differs in many important features from the systems used by other manufacturers. This system combines the best features of the old-time apprenticeship with the characteristics of the modern trade school. The boys not only receive theoretical instruction in an actual school, but they are also given preliminary shop instruction in a special training shop conducted for this purpose alone, and are not placed in the actual shop departments until they have received such training in the operations of the machines of each department as will insure that they will be capable of handling the work that is given to them in a satisfactory manner, without too much personal instruction from the foreman.

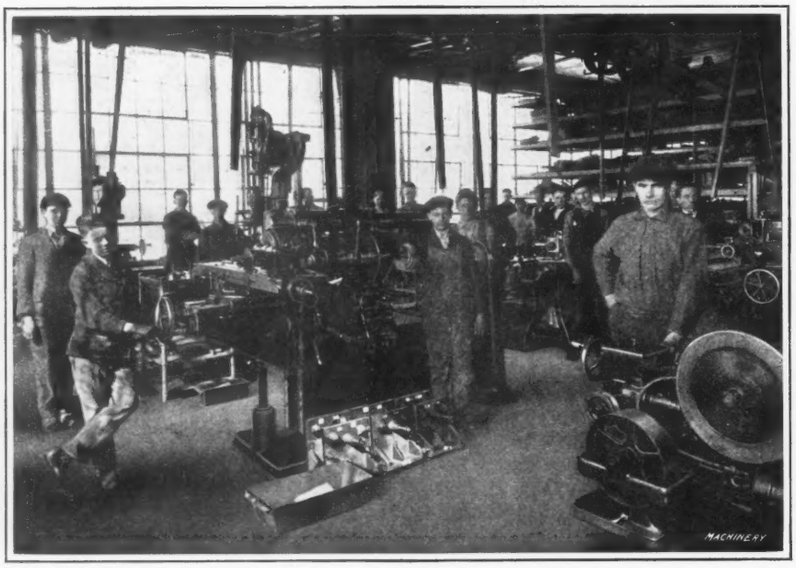


Fig. 1. Training Shop for Apprentices at the R. K. LeBlond Machine Tool Co.'s Plant

transferred to the milling department in the shop. A record of the boy's performance is kept on a blank as shown in Fig. 3.

When he has finished his training period in the milling department, he will come back to the school shop and will then receive his preliminary training on the next type of machine, after which he will be transferred to the department in the shop where that type of machine is used. The special training in the school shop for subsequent departments lasts usually only about one week, but at the time of each transfer from department to department the boy always comes back to the training shop for preliminary training before he is sent to work in the next manufacturing department.

Equipment of the Training Shop

The training shop is completely equipped with standard machine tools including three LeBlond engine lathes, one LeBlond chucking lathe, one upright Cincinnati-Bickford drilling machine, one Kern sensitive drilling machine, one LeBlond universal milling machine, one Brown & Sharpe cylindrical grinder, one Brown & Sharpe gear-cutter, one Gray planer, one Atlas arbor press, five vises, together with the necessary equipment and accessories, chucks, arbors, cutters, tools, etc. The school shop accommodates twenty apprentices at a time, and is engaged on both production and tool-room work, thereby giving the boys an accurate idea of the work in the shop departments before they are transferred to the shop.

Shop Training for Apprentices

The shop work is divided approximately as follows: One year in the lathe department, six months each in the drilling department, the milling department, the planer department, and the grinding department, gear-cutting department, or tool-room; and one year in one of the assembling departments, making four years in all.

At the end of the trial period, when the apprentice agreement is signed, the boy is provided free of charge with a tool chest and such tools as are necessary for him in his work. The title to the tool chest and the tools remains with the LeBlond Machine Tool Co. until the apprentice has completed his apprenticeship, when the tools are presented to him together with a bonus of $100 and a diploma. The set of tools provided for the boys entering on their apprenticeship, is as follows: One No. 1 ball peen hammer, one 7-inch screwdriver, one 4-inch screwdriver, one pair of 6-inch hermaphrodite calipers, one pair of 6-inch inside calipers, one pair of 10-inch outside calipers, one pair of 4-inch outside calipers, one pair of 4-inch spring dividers, one 12-inch combination square, one center-punch, one 3/16-inch pin punch, one 5/32-inch pin punch, one 1/8-inch pin punch, one 6-inch scale, one center gage, one 2-foot rule, one thickness gage, one surface gage, one India oilstone, one cold chisel, one gouge, and one tool chest. The value of the tools supplied to the apprentice exceeds $50. The boy signs for these tools and is required to be able to account for them at any time during his apprenticeship period. Other tools are added from time to time during the apprenticeship as they become necessary in the apprentice's work. In that manner, at the end of the four years, the boy will have tools worth about $100 provided by the firm, which become his property upon the completion of the apprenticeship period.

Compensation Paid Apprentices

The subject of compensation for apprentices is one of great importance. Many manufacturers have stated that it is difficult to obtain apprentices because boys can enter shops with a view to learning to operate one type of machine tools and earn so much more than ordinary apprenticeship wages, that it is difficult to induce young men to enter upon a four-year apprenticeship. The R. K. LeBlond Machine Tool Co. has found no difficulty in this respect. In the first place, the course is so planned that it is truly educational, and the boy views it in the same light as he would a technical education. In addition, he is paid a living wage, which is necessary if the best class of boys is to be attracted under present labor market conditions. Apprentices' wages may have to vary according to locality or conditions, but they must be attractive enough to obtain a good class of apprentices.

Fig. 2. A Class of Apprentices studying Mathematics

The Classroom Training

At the present time there are about 150 apprentices in the LeBlond plant. These are divided into classes of from sixteen to twenty boys to a class. Each class is given classroom instruction twice a week during the regular working hours, for a period of one and one-half hours each time. One of these periods is devoted to mathematical instruction and the other period to drawing. No effort is made to teach mechanical drawing in the ordinary sense, but the boys are taught to make free-hand sketches, following the rules laid down for mechanical drawing, and are thereby enabled to acquire a rapid and accurate knowledge in the reading of blueprints. The boys are also encouraged to attend night classes in mechanical subjects. There are many excellent night classes in Cincinnati, especially at the Ohio Mechanical Institute, the Y. M. C. A., and at the various high schools. Some of the apprentices are diverted from the shop into the drafting-room after they have served at least two full years in the shop. The boys selected for the drafting-room training are those who show the greatest proficiency in the subjects of importance to a machine designer and draftsman. Mathematical and inventive ability, and a general inclination for mechanical drawing, are the main considerations in this connection.

In the same manner, those who show the highest degree of mechanical skill are diverted into the tool-room at the end of two years in the general production departments and receive in the last two years a thorough training upon tool-room work. Patternmakers are trained in the same way. They are given two years' machine shop work, after which the last two years of their apprenticeship are spent in the pattern shop which has proved ample.

Name Roy Sierreveld No. 1529
Started November 3-1919
Apprentice (4) Four year Student
Specialist
Experience 1 1/2 year at Boss Washing Machine Co. Norwood, Ohio.
Course of Instruction
Drill Press. Vise Work Planer
Remarks: Very Good
Transfered to Planer Dept. No. 10, 12/15/19
Form 134

Fig. 3. Training Shop Record of Apprentice

ADDRESS: #4836 Eastern Ave. Cin'ti, Ohio
AGE: 17 years PHONE:
4 year Apprentice CONTRACT SIGNED:
FATHER'S OCCUPATION: Millwright. Cin'ti Shaper Co.
APPLICANTS PREVIOUS EXPERIENCE:
Boss Washing Machine Co. Norwood, Ohio
PREVIOUS EDUCATION:
Thru 1st year Woodward High School
ENTERED OUR EMPLOY: 11/3/19
Roy Sierreveld
Machinery

Fig. 4. Card from the Index recording all Apprentices

The Courses in Mathematics and the Examinations

The classroom course in mathematics includes a review of grammar school mathematics, followed by mensuration, shop problems, cutting speeds, elements of algebra and geometry, trigonometry, logarithms, and the elements of strength of materials, gearing, etc. A series of twenty-five lessons or unit instruction books has been prepared, each one covering one subject. These instruction sheets contain brief rules and problems to be solved. One week, the mathematical classroom work is devoted to the solution of these problems by each boy working by himself, and alternate weeks the work is carried on along the lines of regular classroom work, with the whole class instructed as a unit.

To insure that the boy is obtaining the full benefit of his shop experience, he is given a series of thirty to forty questions relating to shop work at the time when he enters a new department. These questions he answers in writing and must turn in the replies at the time when he is to be transferred to another department. He is required to do most of this work at home, as well as the work required in the solution of the problems on the unit study sheets. As he completes each unit, he is given a test in school to insure that he has thoroughly grasped the subject, and has not obtained merely a superficial knowledge.

APPRENTICE RECORD

Name Roy Sierreveld Dept. No. 10
Machine Tool or Work Planer
A SPEED: The rate at which he works, as compared to speed expected.
B WORKMANSHIP: The grade of finished work, as compared to standard practice.
A ATTITUDE: Personal interest shown in his work, and his conduct in your department.
B KNOWLEDGE: The Amount of general information he has, in line with his work.
A=Very Good. B=Average. C=Unsatisfactory.
In what does this man excel?
Plane Surface and Dove Tail Planing
In what is he deficient?
Signed Louis Nomberger Date 6/3/20
Form 141 NOTE—Send this Report to Superintendent's Office.

Fig. 5. Department Foreman's Report to Superintendent

The Apprentice School Library

An important feature in connection with the apprentice school is the library system which has been inaugurated. The company maintains a well-supplied mechanical library, with books indexed and taken care of on the regular public library plan. The boys are permitted to borrow books for home study, and note is taken of the interest that the boys show in this respect. The instructor advises the boys as to the best information obtainable on any one subject, referring them to the book or section of a book that will give them the information they are seeking. Naturally, when a boy is working in the lathe department, he will be encouraged to study books on lathe work, and so on, according to the department in which he is working. MACHINERY'S Mechanical Library has been found very useful in this connec-

tion, as it has been prepared especially with a view to furnishing instruction along the practical lines required in training mechanics.

Maintaining the Records of the Apprentices

The supervision of the apprenticeship course is in the hands of the assistant superintendent, Frank C. Lang, who has charge of the entire apprenticeship course. He is assisted by the mathematical instructor, and the instructor in the training shop and his assistant, as well as by the employment manager. Records of the boy's performance are kept by the employment department, where he is listed in the regular employment card index as an employe, and also in a separate card index covering all apprentices. (See Fig. 4). This card index is used in connection with the Rand visible vertical file. Colored celluloid riders are placed at the lower right-hand corner of the card one month in advance of the date when the boy is to be changed to the next department. This gives time to prepare another apprentice for the vacancy at the time of the change. A record is also kept by the classroom instructor covering the details of the boy's classroom work.

At the end of each six months, or at the end of each period in a department, the foreman of the department makes a written report, Fig. 5, to the superintendent of the company, giving completely and in detail his opinion of the boy's work and progress. These reports are placed in a permanent file and constitute a continuous record of the boy's progress. The employment department also keeps a card index record, which, in addition to the information given by the boy on his application blank, contains data relating to when he actually started work, dates of transfer from department to department, etc. The records of the classroom instructor contain the marks obtained by the boy in his various examinations and the record of his attendance. An attendance record is also kept by the employment department.

An individual efficiency record of the boy's work in the shop, similar to the chart maintained for recording the individual efficiency of the men in the plant, which was shown in the article "Time Study and Rate Setting in a Machine Tool Plant," published in the July, 1919, number of MACHINERY, is also maintained for each boy. From these various records a complete history of the boy's performance from the time he enters the apprenticeship course until he completes it can be obtained at any time.

Conclusion

As a result of the care with which the company selects its apprentices, an unusually fine body of young men has been assembled, and it is believed that it is well worth taking great care in choosing the right boy for the course because of the expense connected with it. It costs more to try to train and educate a less well qualified boy than one with better qualifications, and the result, of course, is less satisfactory. Hence, with the same time and effort spent upon the training of a boy of the right kind, there is an assurance of a man who will ultimately become a first-class mechanic and who, if he possesses in addition to mechanical skill the required executive ability, will some day become a mechanical leader in the industries.

* * *

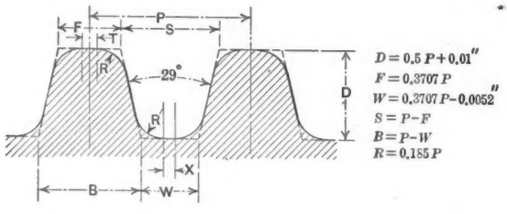
SPECIAL FORM OF ACME THREAD

By H. A. PEARSON

The standard Acme screw thread on a male member frequently roughs up and injures the thread on the mating part, especially in cases where the male member is made of harder material than the female part. A case in point is encountered frequently in valve work, where the stem is of harder composition than the bonnet in which it fits. Upon investigation the presence of burrs on the edges of the male thread will often be seen, the action of which, when the stem is turned will produce the injurious effect mentioned, and in time will completely wear away the bearing surfaces of the female thread. These burrs are difficult to remove from the standard form of Acme thread on account of its sharp edges, and it is rarely that these threads are produced without leaving a few burrs. To meet this condition, a special Acme thread having rounded corners has been designed which completely eliminates the difficulty. This form of thread can be cut much more easily than the standard form having sharp edges.

The accompanying table contains the specifications for this special form of thread for screws up to 10 threads per inch. The angle of the thread, its width *F* at the top, and the width *W* of the space at the bottom are the same as the standard Acme screw thread elements. Radius *R* depends on the pitch, and has been calculated so as to reduce the bearing surface of the thread as little as possible, or just sufficiently to produce the desired rounded edges. The form of the thread is shown in the accompanying illustration.

SPECIFICATIONS FOR SPECIAL ACME THREAD (Inches)



Threads Per Inch N	Pitch Single Thread P	Depth of Thread D	Width Top of Thread F	Width of Space at Bottom W	Width of Space at Top S	Thickness at Bottom B	Radius R	True Flat at Top T	True Flat at Bottom X
1	1.0000	0.5100	0.3707	0.3655	0.6293	0.6345	0.1850	0.0964	0.0912
1½	0.6670	0.3433	0.2471	0.2419	0.4196	0.4248	0.1233	0.0643	0.0591
2	0.5000	0.2600	0.1853	0.1801	0.3147	0.3199	0.0925	0.0481	0.0429
3	0.3330	0.1767	0.1236	0.1184	0.2097	0.2149	0.0617	0.0320	0.0268
4	0.2500	0.1350	0.0927	0.0875	0.1573	0.1625	0.0463	0.0242	0.0190
5	0.2000	0.1100	0.0741	0.0689	0.1259	0.1311	0.0370	0.0192	0.0140
6	0.1667	0.0933	0.0618	0.0566	0.1049	0.1101	0.0308	0.0160	0.0108
7	0.1429	0.0814	0.0530	0.0478	0.0899	0.0951	0.0264	0.0139	0.0087
8	0.1250	0.0725	0.0463	0.0411	0.0787	0.0839	0.0231	0.0121	0.0069
9	0.1111	0.0656	0.0412	0.0360	0.0699	0.0751	0.0206	0.0108	0.0056
10	0.1000	0.0600	0.0371	0.0319	0.0629	0.0681	0.0185	0.0097	0.0045

Machinery

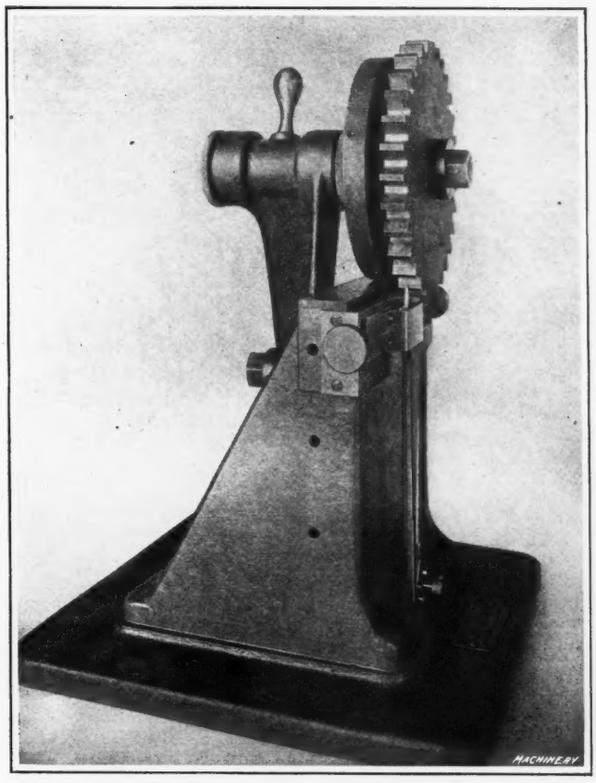


Fig. 1. Machine developed by Illinois Tool Works for testing Accuracy of Involute Gear Teeth

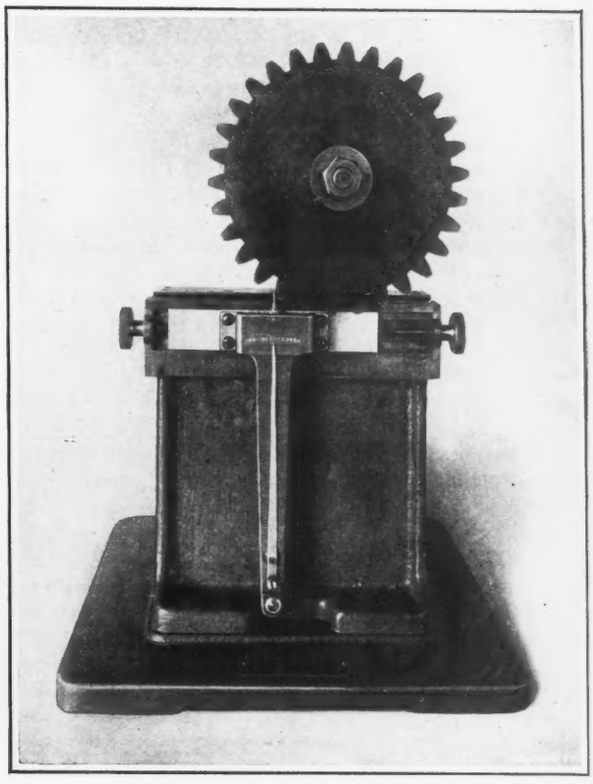


Fig. 2. Front View of Involute Gear Tooth Testing Machine showing Arrangement of the Indicator

Involute Gear Tooth Testing Machine

THE Illinois Tool Works, 154 E. Erie St., Chicago, Ill., have developed a machine for testing the tooth form of involute gears that provides for making such tests with a high degree of accuracy. Figs. 1 and 2 show two general views of this gear-testing apparatus, and Fig. 3 illustrates the mechanism in detail. At the top of the machine there is a track on which a disk *A* is rolled, this disk being of the same diameter as the base circle of the gear to be tested. The gear is secured at the front of an arbor that also carries disk *A*, so that the gear and disk rotate together. A contactor *B* engages the gear tooth to be tested, and has the center of its head level with the track on which disk *A* is rolled. This contactor is pivoted at *C*, and by means of a pin at its lower end, connection is made with an indicator needle *D*, which is supported by a pivot *E*. In this way a system of multiplying levers is made effective. As each gear tooth rolls in contact with the point *B*, any error in the tooth form imparts a corresponding movement to the contactor head *B*, and owing to the magnifying effect of the levers, even the slightest movement of the contactor head causes needle *D* to make a considerable movement over scale *F*, which indicates the error in tooth form.

No movement of the contactor head *B* will occur so long as the involute curve of the tooth is perfectly accurate. Hence, any movement of the indicator needle *D* over scale *F* shows that the form of the gear tooth is inaccurate, and the magnitude of this inaccuracy is indicated by the scale. A ratio of 100 to 1 for the system of multiplying levers that transmit movement from the contactor head *B* to the point of indicator needle *D* running over scale *F*, provides for a wide spacing of the graduations on this scale which indicate errors of thousandths of an inch, so that the operator can easily and accurately determine the exact magnitude of any error which is discovered. This is an important feature in the practical application of the device.

How the Machine is Constructed

Having made a general statement as to the purpose of this machine and the way in which the desired result is obtained, we are ready to describe the arrangement of the mechanism. It was explained that disk *A* is of the same diameter as the base circle of the gear to be tested and that this disk rolls on a track on top of the machine bed. Guides *G* support a cross-head *H* that carries a horizontal stud *I* on which a rocker arm *J* is pivoted. The function of this rocker arm is to cause the disk *A* to roll a predetermined path on its track. Cross-head *H* permits the necessary vertical movement of stud *I* as arm *J* rocks back and forth to roll the disk on its horizontal track. At its upper end, arm *J* is provided with a housing supporting ball bearings in which an arbor *K* is carried. Disk *A* is secured to the arbor *K* in such a manner that as the disk rolls on its track it causes the arbor to rotate; and as the gear *L* to be tested is rigidly clamped to the arbor by means of a nut and spacing collars, it will be evident that the gear rotates in unison with the disk. Both the gear and the disk may be taken off from the arbor by removing the clamping nut and drawing them off the forward end. Should it happen that the next test is to be made on a gear of a different diameter or pitch a disk *A* of suitable size will be substituted, and this will bring cross-head *H* into a different position in its guides on the frame of the machine. The handle at the top of rocker arm *J* forms a convenient means of rolling the disk *A* on its track.

Arrangement of the Indicator Actuating Mechanism

Contactor *B* is supported on a pivot *C* that is carried at the upper end of a panel *M*, this panel being rigidly fastened to a carriage *N* which travels in horizontal ways near the top of the main frame of the machine. The position of the carriage is controlled by adjusting screws *O*. At the lower end of the contactor arm there is a pin *P* which extends

forward through an opening in panel *M* and enters a vertical slot *Q* formed in the lower end of the indicator needle *D*. As previously stated, this needle is pivoted at *E* on a stud carried by the panel slightly below slot *Q*. As shown in the illustration, the upper end of the indicator needle *D* runs over scale *F* which is graduated on the front surface of the panel, and the system of levers giving a multiplication of 100 to 1 enables the scale graduations to be broadly spaced so that they are easy to read.

Provision for Holding Contactor against Opposite Sides of the Teeth

Provision is made for holding the contactor head *B* in engagement with the surface of the gear tooth to be tested, and a simple adjustment enables the contactor to bear against either side of the tooth. The means provided for this purpose consist of a double spring *R* which is held to the panel

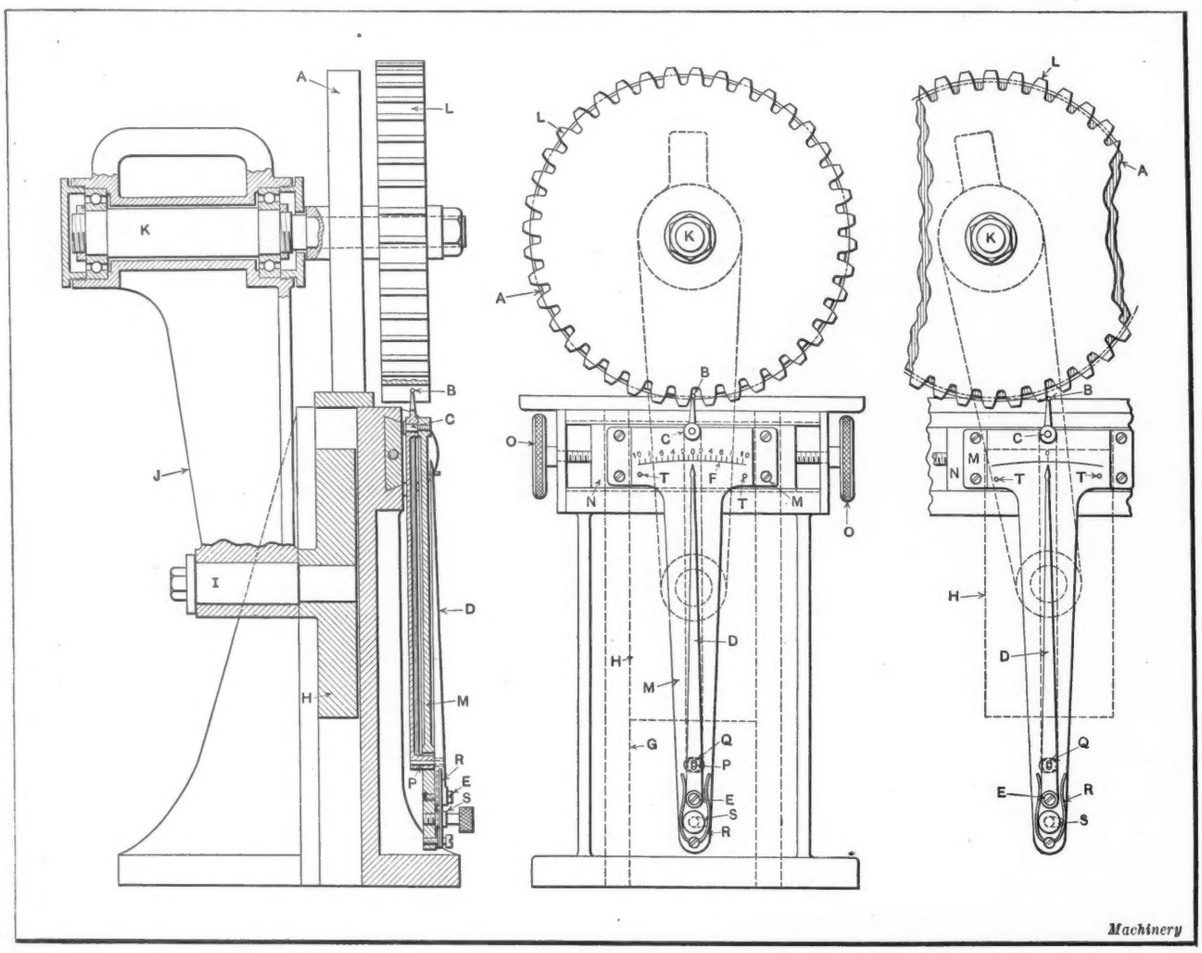


Fig. 3. Side and Front Views of the Involute Gear Tooth Testing Machine, illustrating Important Members of the Mechanism

M by means of a screw and projects upward to bear against either side of the lower end of indicator needle *D*. Pin *S* is mounted in the panel below the bottom of the indicator needle so that it is free to rotate, and it is provided with a finger which may be thrown into engagement with either side of the spring, thus relieving the pressure of that side of the spring from the indicator needle and causing the contactor *B* to engage the proper side of the gear tooth to be tested. When it is required to test the opposite side of the gear tooth, finger *S* is thrown over to reverse the action of spring *R* on the indicator needle. Stop-pins *T* are placed on panel *M* near the ends of scale *F* to provide for limiting the distance through which the indicator is free to swing.

Method of Using the Machine

In preparing to conduct a gear test on this machine, the disk *A* and gear *L* are mounted on the arbor *K*, as previously explained. Next the carriage *N* is adjusted by manipulating screws *O* until the contactor *B* is located in a central position when in engagement with the acting surface of the gear tooth to be tested, namely, in the position indicated in the front view of the machine in Fig. 3. Under these conditions, the indicator *D* will also occupy a central position over the zero graduation on scale *F*. After making these adjustments, the operator grasps the handle on rocker arm *J* and slowly moves it in a direction to move the engaged tooth away from the contactor. Thus, in practice, with the contactor engaging the right-hand side of the tooth as shown, the operator moves the handle of arm *J* in a direction that causes disk *A* to roll toward the left, as indicated by the partial view at the right-hand side of the illustration. A perfect tooth will not cause any lateral movement of the contactor *B*, but if the tooth is of imperfect form, the head of the contactor will be caused to move in one direction or the other, thus producing a corresponding but greatly magnified movement of the free end of the indicator *D* over scale *F*. In this way, the user of this machine is able to ascertain both the presence and magnitude of any imperfections in the form of the gear teeth. Gears of various pitch diameters may be tested on a machine of this kind, without changing anything except the size of roller *A*.

Principle Governing the Design of the Machine

This machine operates on the same principle that governs the tracing of an involute curve. According to definition, an "involute" is the path traced by a point at the end of a taut string during the period that it is being unwound from a cylinder. The same curve will be generated by a point in a straight line or tangent to the cylinder, which is rolled on the cylinder without slipping. In the involute gear tooth

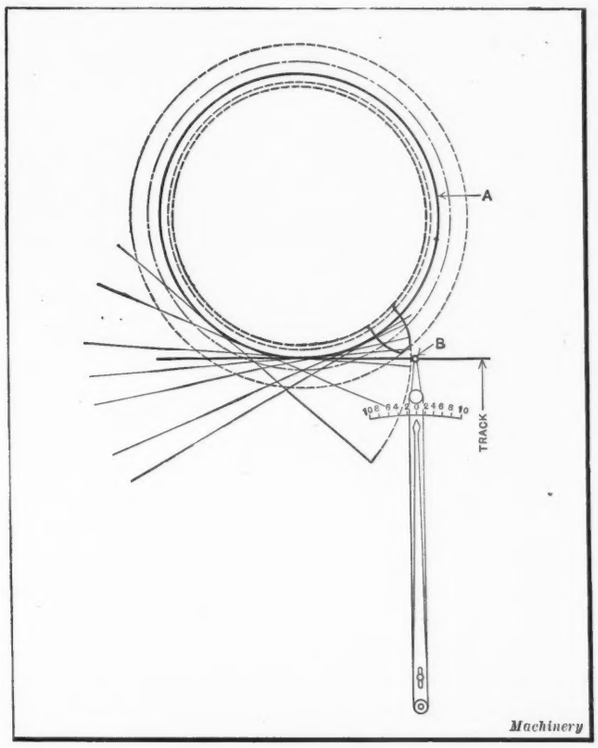


Fig. 4. Diagram illustrating Principle governing Design of Gear Tooth Testing Machine

testing machine, the cylinder is represented by a disk *A* of the same size as the base circle of the gear to be tested, and the straight line or tangent is represented by the track on which this disk is rolled. The tracing point on this tangent is represented by a small ball-shaped contactor *B* supported at the end of a multiplying lever and located with its center on a level with a track that carries the disk. The gear to be tested is mounted and clamped integral with disk *A* (see Fig. 4) and the contactor point *B* is adjusted until it presses on one tooth of the gear, with the indicator registering zero. The indicator dial is graduated in divisions representing 0.001 inch, and the multiplying levers increase the sensitiveness of the measurement by a ratio of 100 to 1. This large magnification makes it possible to detect the most minute errors in the involute tooth form by simply rolling the gear past the contactor point *B*. Quite obviously, if the gear tooth contour conforms to a true involute, the indicator needle will not move from its zero position; and, conversely, any movement of the needle shows an inaccuracy in the tooth form.

* * *

COLORED LIGHT SIGNAL SYSTEM FOR LOCATING EXECUTIVES IN A SHOP

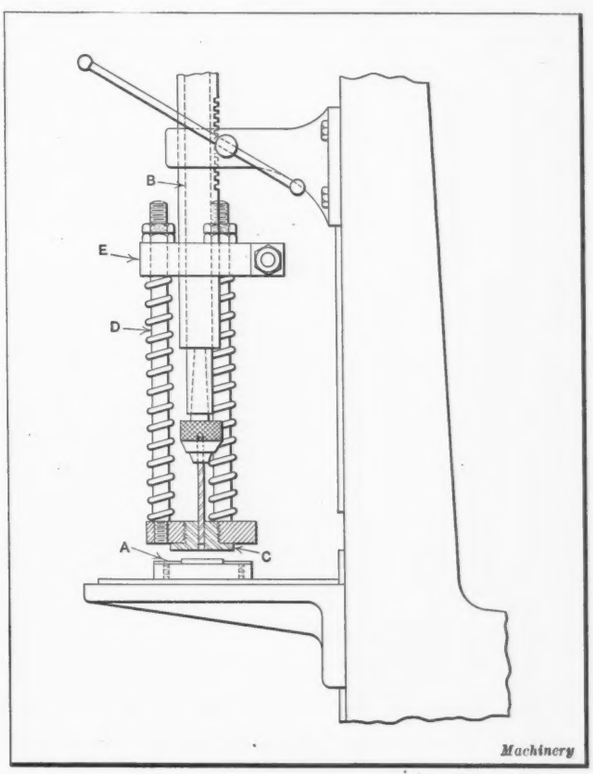
Various signal systems are in use in manufacturing plants for locating executives and foremen when they are not in their own departments. A system employed by the De Laval Separator Co., Poughkeepsie, N. Y., is the use of different colored lights in which a series of ten or twelve are mounted in a suitable socket board. These boards are prominently located throughout the shop and in various parts of the office, or even in the yard, so that no matter where the executive may be, his attention will be attracted by the flash of the lights. Single lights may be used for the executives and combinations of two or more for the foremen, so that when any particular light or series is flashed, the man sought will know at once whether or not it is a call for him. These lights are operated from the telephone switchboard so that when a telephone call fails to reach the official at his desk, the operator immediately plugs in his combination of lights with the result that he will be quickly brought into communication with the official.

ATTACHMENT FOR DRILLING MACHINE

By GUSTAVE F. BAHR

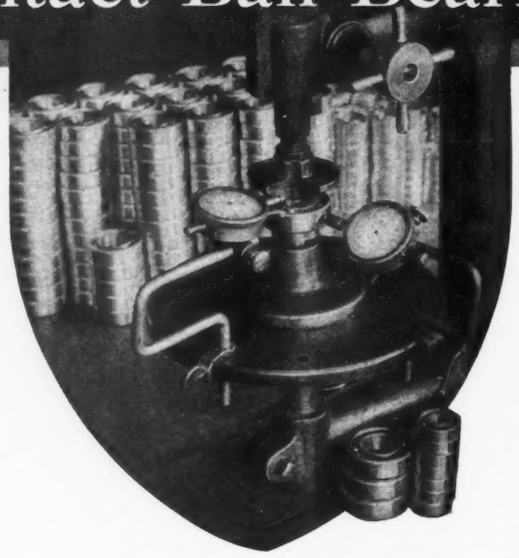
A reaming and drilling attachment, recently designed for use on a drilling machine, is here illustrated and described. This device was designed to do away with elaborate drill jigs and reaming blocks for holding work in which the hole need not be machined precisely. There are numerous small pieces of this kind which ordinarily employ a leaf jig or some other expensive holding device when drilling and reaming the holes. In the attachment illustrated, however, a locating plate *A* containing either a nest or a series of pins arranged to locate the work is employed. This locating plate is securely attached to the table of the machine in the proper relation to the machine spindle. If the spindle *B* is lowered, the holding pad *C*, which can be made to suit the shape of the work if necessary, will be brought down into contact with the work because of its connection to the spindle sleeve. A clamping ring *E* is attached to the sleeve, and carries three guide rods *D*, the lower ends of which are threaded and carry the ring in which the holding pad is assembled. The coil springs carried on these guide rods exert the necessary amount of pressure on the work, as determined by the position of ring *E* and the adjustment of the nuts on the guide rods. If desired, the drill may be guided in the holding pad by a bushing, but a simple clearance hole will often suffice. It is evident that as the spindle sleeve is lowered an increasing amount of pressure is produced so that the deeper the hole becomes, the greater is the force exerted. This, together with the arrangement for producing any desired initial spring pressure on the work, assures that the part to be drilled will be securely held at all times.

This arrangement has also been successfully used in reaming operations, the advantage being that, by reason of the spring pressure on the reamer, all chattering of the hole is eliminated. One other advantage of this attachment is that it is a safety device, in the sense that chips caught on the drill cannot cut the hand. An attachment of this type will speed up production, and can be made with less expense than the usual type of drill jig.



Drilling and Reaming Fixture which holds Small Parts by Spring Pressure

Manufacturing Three-area Contact Ball Bearings



A Detailed Description of the Manufacturing, Inspection, and Assembling Methods Used in the Shops of the Federal Bearings Co., Inc., Poughkeepsie, N. Y., in Producing Three-area Ball Bearings

Second of Two Articles

IN the first installment of this article, published in the August number of MACHINERY, a general description of the Federal three-area ball bearings was given, together with a detailed description of the operations that are performed in the manufacture of the various parts of which the bearing is composed. In the present installment the methods by which bearings of this type are inspected and assembled, and the final testing and truing up operations will be dealt with.

Inspection Methods

The inspection and assembling of the bearings is carried on jointly, and each bearing is given a running test before it leaves the factory. One of the inspection benches is shown in Fig. 11. After the inner rings have been delivered to the inspection department they are first inspected for eccentricity of the diameter of the raceway, the rings being held between centers on an arbor. A dial indicator mounted on a base which rests on a surface plate is employed in this operation. The eccentricity limit of the raceway diameter is 0.0003 inch. After the eccentricity has been inspected the diameter of the raceway is tested in a similar manner.

In this connection special attention should be called to the assembling methods followed, in which both the inner and outer rings of each bearing number are assorted, according to diameter tolerances, into various classes, each of which, starting with the lowest permissible diameter, establishes a series of slightly varying diameter sizes, so that the entire series is within the maximum and minimum limits allowed for that particular size bearing. It can readily be seen that if this means of sorting into sub-classes is followed on both the inner and outer rings a combination of two outer rings and one inner ring can be selected which will enable the same over-all limits to be maintained in the assembled bearing as would be the case if each ring were required to be machined without tolerance, or at least to exceedingly close limits. The results, however, are identical, but this practice of classifying the tolerances obviates the necessity of grinding the races in the rings to the accurate limits which, nevertheless, by this grading process finally become established in the bearing. In the general view of the assembling bench, Fig. 11, will be noticed on the right the ends of a number of long slender dowels. These dowels or pegs are set into boards which rest on the floor and over which the rings are placed by the inspector after being sorted. In following out this idea of assembling, special trays are employed on which component parts are placed, two outer rings and an inner ring together, and of such a combination that the over-all dimension will be correct in the assembled bearing. These trays may be seen in the left foreground of the illustration Fig. 11, where the assembling department is shown, and also very clearly in Fig. 14 which illustrates the loading operation.

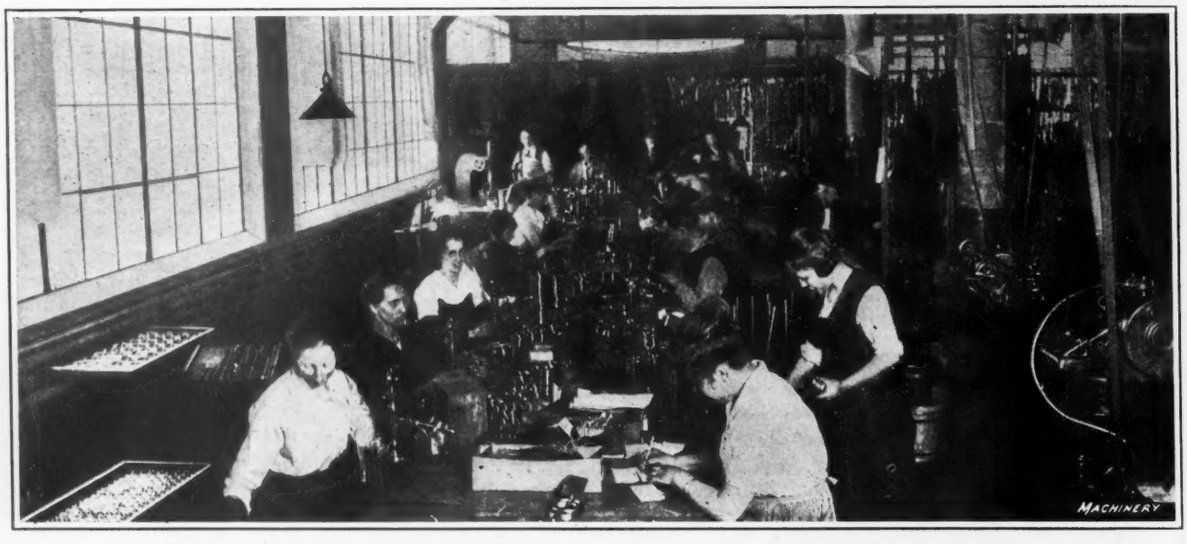


Fig. 11. Assembling and Inspecting Department showing Gaging Devices for inspecting the Raceway Diameters

The process of verifying the depth and definite location of the ball track in the outer race rings is illustrated in Fig. 12, in which the dial indicator arrangement employed is plainly shown. This is the inspection operation which determines the proper peg or dowel on which the rings are to be placed in the sorting of the parts.

The precaution of mating up the inner and outer rings would be of no avail if the balls used in the bearing were not similarly assorted. A standard high-grade commercial ball such as the well-known Hoover or Atlas product is used in these bearings, and these balls are graded after being received in the assembling room. It has been found that all the balls of one particular shipment, for instance, may be well within the required limits, but that the product of various shipments and possibly of various concerns will vary enough to warrant the precaution of testing each individual ball. The special equipment employed in this operation is shown in Fig. 13, in which each ball passes under the indicator point, all balls being graded into sizes varying by 0.0001 inch in diameter; thus all the balls that go into a bearing will be of uniform diameter within this close limit, and as nearly perfect in regard to roundness as commercial manufacturing methods will permit.

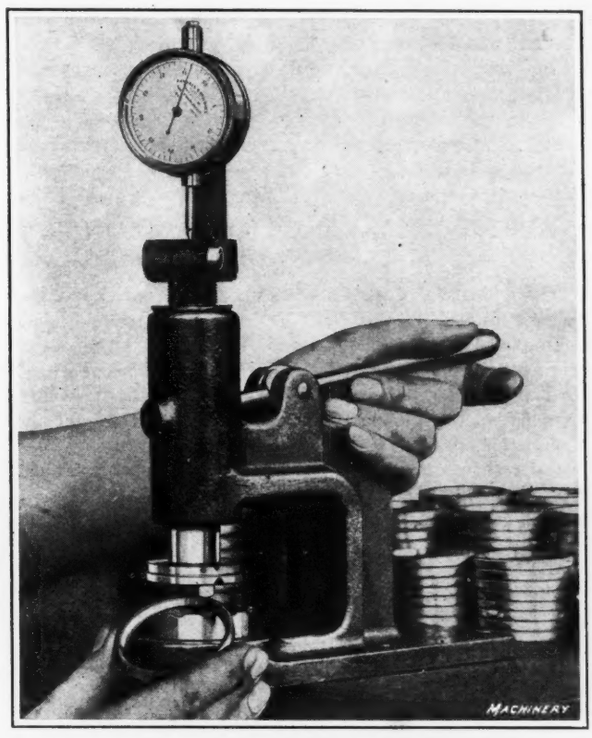


Fig. 12. Testing the Ball Race of the Outer Rings

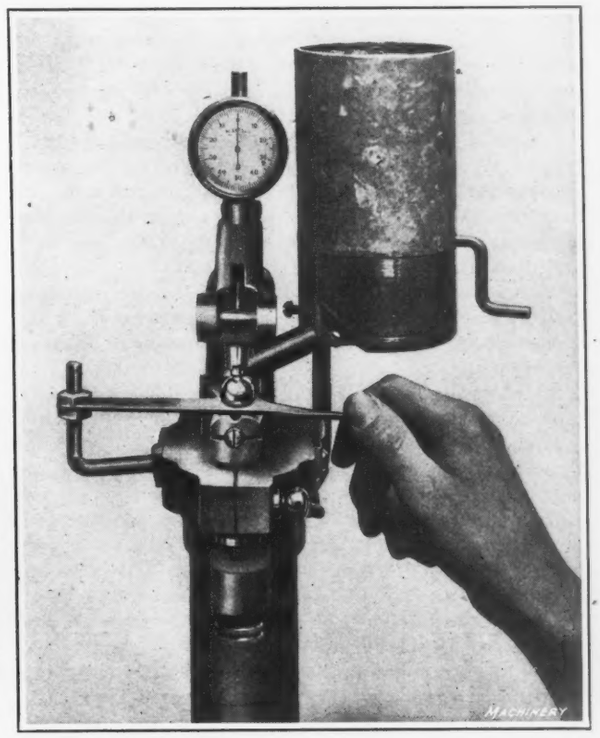


Fig. 13. Equipment for gaging the Diameter of the Balls

Assembling the Bearing

The process of assembling necessarily merges with that of inspecting. From the inspection bench the trays containing the paired inner and outer rings are taken to a power press, where one of the outer race rings is pressed into the case. It will be remembered that, in the manufacture of the case, a flange was produced on one side when the center hole was punched out, but that the opposite side was left open in order to permit assembly. The first outer ring to be assembled is forced against this flange and replaced on the board with the other outer ring and the inner race ring, and delivered to the bench where one of the most interesting steps in the entire assembly is performed. This operation is shown in Fig. 14, from which the arrangement of the parts in the assembly tray may be clearly seen. It consists of loading the bearings, that is, placing the inner race ring and the separator cage or retainer carrying the balls, into the case. The operation and the arrangement of parts on the assembly tray may be plainly seen in the illustration, as well as a collection of assembled bearing parts just before they are inserted into the bearing jacket. A male and a female interlocking retainer are locked together and slipped over an inner ring, the two being held between the thumb and forefinger, and the balls dropped in loosely while the hand is turned. It requires considerable dexterity on the part of the assembler to perform this loading operation without permitting the parts to become disassembled, as can easily be understood. After all the balls have been dropped into the cage, the entire collection of parts is slipped into the jacket against the outer ring which has previously been assembled.

The operation of assembling the other outer ring is performed on an arbor press, in which it is forced down into contact with the balls. The reason for employing an arbor press on this operation is obvious, because under no conditions should the ring be forced against the ball so hard as to cause any misalignment of the bearing, for it will be remembered that at this stage of assembly the balls are held loosely by the retainers. The use of a power press would not be practicable in such a case, where the work must form the stop.

The next operation consists of spinning-in the bearing jacket, and this is performed on a special machine employing two spinning heads. The machine and equipment employed in this operation are shown in Fig. 15, which also shows a bearing held in the chuck of the machine and the relation of the radial spinning tool to the edge of the bearing jacket. The horizontal head *A* which spins the stock parallel with the side of the bearing, and the radial head *B* which, when swung around, completes the spinning operation by folding the metal in against the outer race ring, may be clearly seen. By referring to the sectional view shown in Fig. 1 in the first installment, the condition of the case after this operation may be observed.

The loosely interlocking retainer ledges are next closed together about the balls, which produces the desired rigidity of construction as well as ease of operation, and in addition furnishes a wall on each side of the balls as a provision for increasing the axle-load capacity of the bearing. The ledges are the spacing provision made for the bearing balls.

Testing and Final Truing-up Operations

Each bearing after assembly is subjected to a running test under a known amount of end thrust pressure as determined by the size of the bearing. The bearing is centered on the inner race ring bore, held in a vertical machine especially arranged for the purpose, and the test is made at the maximum safe running velocity. The running qualities are then inspected to see if there is any looseness or binding in the operation, after which one side of the bearing is rough-ground. The purpose of rough-grinding at this stage of the manufacture is to furnish a bearing surface from which the running truth of the side of the bearing can be established. If the bearing is rejected at this point, whatever parts are possible to be salvaged are disassembled. If it passes this test, it is then taken to a Blanchard grinding machine equipped with a magnetic chuck and the rough-ground surface is used as a bearing surface for finish-grinding the opposite sides of the bearing. The work is then reversed and ground parallel on the other side. This machine is of the same general type and the arrangement is practically the same as for the grinding operation shown in Fig. 7, in the first installment, and the cleaning and demagnetizing operations which follow the grinding of the outer rings also follow this grinding operation.

Fig. 14. The Loading Operation consists of inserting an Inner Ring into Two Interlocked Retainers in which the Balls are dropped. These Loose Parts are then inserted into the Bearing Jacket

All burrs and other irregularities on the inside edges of the bearing jacket or case are next removed in a speed lathe provided with a suitable chuck for holding the work, after which a number of bearings are mounted on an arbor and a light cut taken on the outside diameter of the case preparatory to the final grinding operation. In taking this step the bearings are held on an expansion arbor mounted between centers and ground on a Norton cylindrical grinding machine. Following the grinding operation, the bearings are dipped in gasoline and cleaned by air pressure.

After the bearings have been returned to the inspection bench the bore of the inner race is inspected, and then the eccentricity of the outside diameter of the bearing and the running truth of the sides are simultaneously inspected by employing a testing apparatus which consists primarily of two dial indicating gages mounted as shown in the heading illustration. Bearings which have passed inspection up to this point should show no inaccuracy as regards eccentricity or running truth. The inspection of the outside diameter for size, which follows the eccentricity inspection, completes the gaging work on the bearing. The limit established for outside diameter is plus 0.0000, minus 0.0006 inch. Finally the bearings are stamped with their bearing number and size, and are then treated to a coating of pure lubricating grease, which is run over the bearings while hot and which leaves a clean viscous coating after solidifying. Fig. 16 shows equipment used in the laboratory for the purpose of making the final tests to which every bearing is subjected before being put on the market.

* * *

INDUSTRIAL COST ACCOUNTANTS ASSOCIATION

The Industrial Cost Accountants Association was recently organized in Chicago, Ill., by representatives of leading manufacturers in various lines of industry. The object of the new association is the standardization of accounting and cost terminology and the adoption of standard governing principles; the promotion of active cooperation and interchange of average experiences between representatives of manufacturers engaged in similar activities; the education of the members and their business associates in the complex economic problems of industry; the assisting of standardization committees in each line of industry in establishing uniform accounting and cost practices; and acting as a clearing house in distributing to all members the development in cost practices to the end that uniformity, once established, may be maintained. The headquarters of the association will be in Pittsburg, at the office of the secretary-treasurer, 1501 Peoples Bank Building.

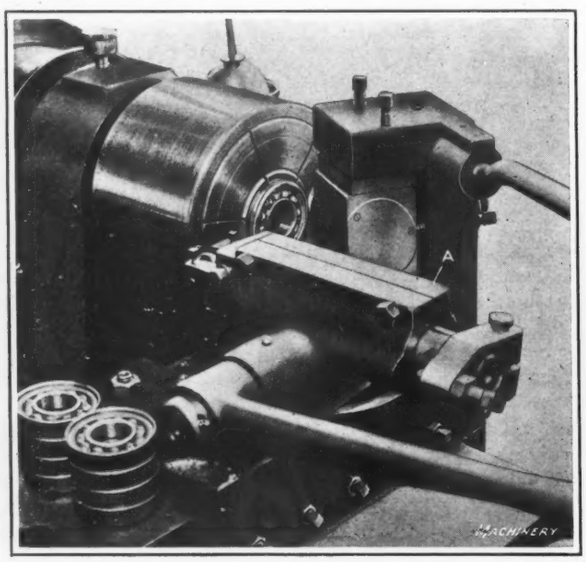


Fig. 15. Machine equipped with Spinning Heads for spinning in the Bearing Jacket after the Component Parts have been assembled

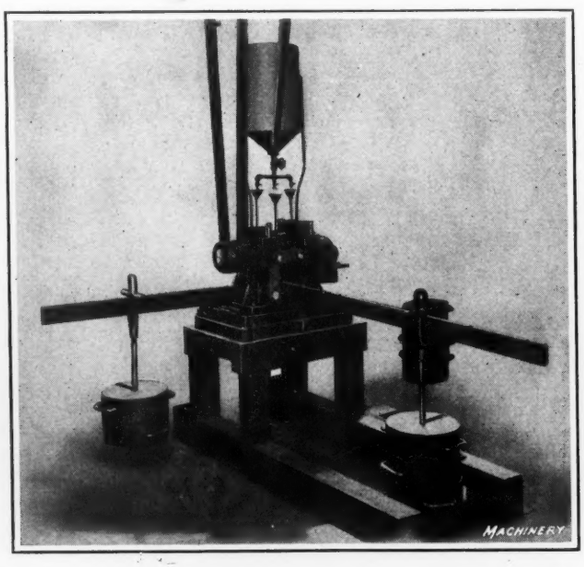


Fig. 16. Laboratory Equipment employed in testing the Bearings under a Known Amount of Both Axial and Radial Load

CALCULATIONS FOR INSPECTING SPECIAL PROFILE GAGES

By V. E. AYRE

When checking the gage shown in Fig. 1, first measure the angles a and b in relation to the finish-ground surface, by means of a sine bar. On page 1176 of the August number of MACHINERY, a formula was presented for finding a radius by means of a V-block, depth micrometer, and ground disk. This formula, $r = R - H$ (2.41422), may now be employed to test radius r, after which the distances A, B and C are measured and the heights D and E calculated from the measurements of the angles a and b and the radius r.

$$D = H + G \qquad (1)$$
$$H = F \tan a$$

But

$$F = A - r + r \sin a$$
$$= A - r\,(1 - \sin a)$$

Therefore

$$H = [A - r\,(1 - \sin a)]\ \tan a$$

Also

$$G = r \cos a$$

Substituting these values of H and G in Equation (1),

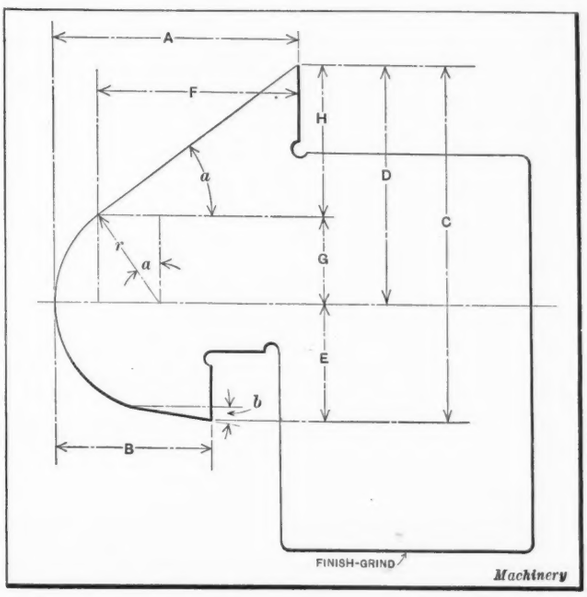


Fig. 1. Special Gage and Measurements Necessary in its Inspection

$$D = [A - r\,(1 - \sin a)]\ \tan a + r \cos a$$

By a similar method of calculation the value of E may be expressed by the formula

$$E = [B - r\,(1 - \sin b)]\ \tan b + r \cos b$$

It is evident that the sum of the values D and E should equal the measured distance C. Care must be taken when making calculations on this type of gage to use the actual point of tangency of the straight and curved surfaces of the gage when making the measurements.

Fig. 2 shows the set-up for inspecting a gage that is used to test the profile of a shell, while Fig. 3 is a similar diagram of the check for the profile gage. The inspection of these two gages includes a test of the radius of curvature R, as well as the location of the center of curvature with respect to the nose of the profile.

Two straightedges are first clamped to a surface plate at 90 degrees to each other, after which the curvature is checked by the disk method. This method consists, briefly, of locating two disks; first E is located according to the dimensions A, and B, and then reference disk F according to the radius R. An indicator, attached to rod G, Fig. 3, is swung like a compass about the center of disk E, first against the reference disk and then against the curvature. The error is then determined as explained in the article

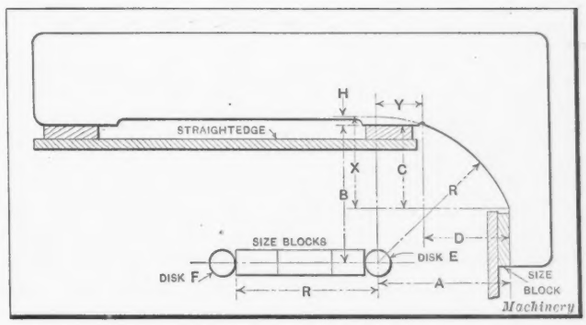


Fig. 2. Shell Profile Gage and its Inspection Set-up

"Testing the Radius of Curvature of a Gage," published in the July number of MACHINERY, page 1076. The dimensions A and B may be varied by means of size blocks placed between the straightedges and the gage, as shown by the diagrams. Size blocks may also be employed to locate the reference disks. Should the indicator show any deviation between the radius of curvature and the established radius, simply correct the position of the gage by varying the dimensions A and B by means of the size blocks, until the indicator does not show any variation when swung over the curvature.

Quite often the radius of curvature is correct but the position of the center with respect to the nose of the profile is not correct. As an illustration, if the radius R and one of the locating dimensions (for instance B) is nominally correct, the other dimension A, may be wrong, which would result in the dimensions C and D, which locate the intersection of the curvature with the straight faces, being correspondingly affected. These specified dimensions, C and D, Figs. 2 and 3, may be checked as follows:

$$H = R - B$$
$$Y = \sqrt{H(2R - H)}$$

equals one half the length of a segment of height H, which is an adaptation of a formula given in MACHINERY'S HANDBOOK, page 132,

and

$$D = A - Y$$

According to the formula for finding the height of a segment, also given in MACHINERY'S HANDBOOK, page 132,

$$h = r - \tfrac{1}{2}\sqrt{4r^2 - c^2}$$

In this case, therefore

$$X = R - \tfrac{1}{2}\sqrt{4R^2 - 4A^2}$$
$$= R - \sqrt{R^2 - A^2}$$
$$C = X - H$$

It is, of course, evident that dimensions C and D may be similarly checked, no matter which of the three dimensions A, B, or R is incorrect, and also that the result of this inspection will enable the relation between the center of curvature and the nose of the gage to be correctly established.

* * *

Where a belt is to be shifted automatically, as on a planer, the belt speed should not be less than 1000 feet per minute.—*From a catalogue of the Chicago Belting Co., Chicago, Ill.*

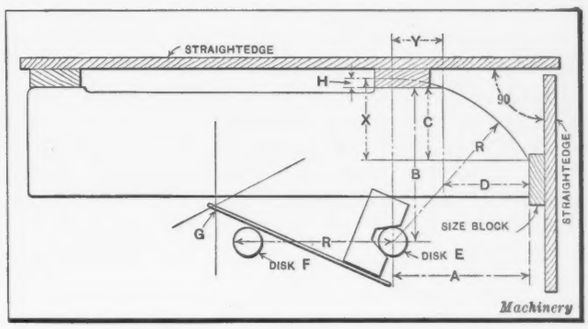
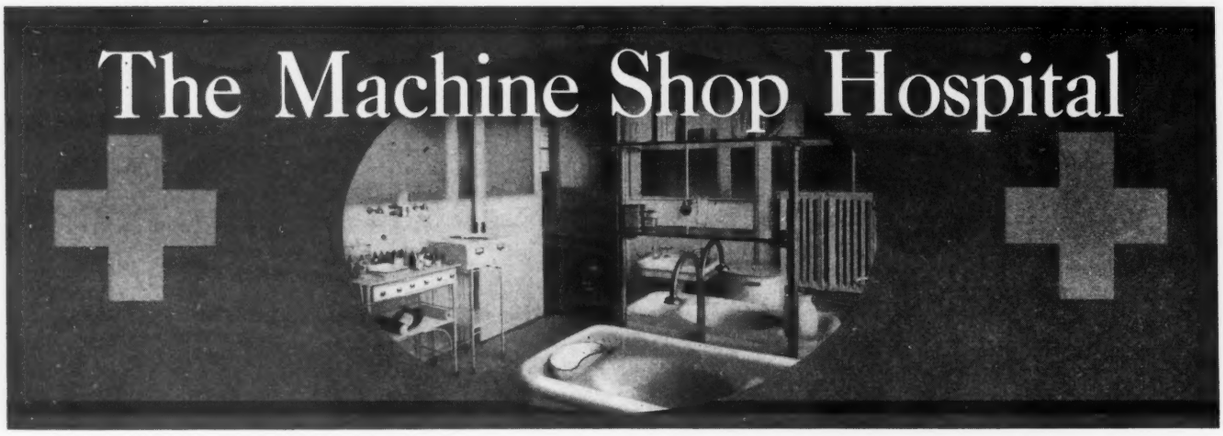


Fig. 3. Check for Gage shown in Fig. 2, and its Set-up

The Machine Shop Hospital



By SANFORD DeHART, Director of Hospital, R. K. LeBlond Machine Tool Co., Cincinnati, Ohio

The purpose of this article is to outline the requirements and point out the value of an industrial hospital in a plant of moderate size. Complete medical service has until recently been limited to large manufacturing plants; but health service is just as essential in a factory of moderate size as it is in a larger plant. Adequate service of this kind can be provided for the smaller shops at a cost that is not excessive, thus assuring them the same advantages in this respect as are enjoyed by the larger corporations.

IN the planning of an industrial hospital for a machine shop employing from five hundred to one thousand men, five rooms are required—a waiting room, a first-aid room or dressing room, an eye-room, a rest room or bedroom, and an office. The floor plan shown in the accompanying illustration indicates the equipment ordinarily needed for this purpose.

The most important requirement for the success of an industrial hospital is the experience and training of the personnel of the hospital for competent industrial service. The training of the average physician is somewhat foreign to that required in industrial service. He is trained to seeing only individual cases, and does not view health, or the lack of it, in its community aspect. Industrial hospitals have been failures in some instances, because the physician in charge has not had the necessary qualifications for this kind of medical work; the managers of the industrial undertaking selected him because he was a reasonably successful general practitioner. This, however, did not guarantee that he would make a success as an industrial physician. Failure to appreciate this point has caused a great many disappointments in the way of unsatisfactory medical service.

The Qualifications Required of the Medical Director in a Shop Hospital

To meet the present-day industrial situation, the medical director should be well informed on accident prevention as well as on sickness prevention; in the latter field particularly he will find unlimited possibilities. He must be a man who recognizes that he is no longer expected merely to treat symptoms but to prevent disease. He should be able to teach his patients that health cannot be administered from a teaspoon, and that there are only seven or eight out of about 150 diseases known to medical science for which there is a drug that can be given with any pretension to cure.

He should also be familiar with modern employment methods and group insurance, and thoroughly posted upon the occupational requirements of the shop; otherwise, he cannot attempt physical examination with a view to placing the physically unfit in positions that they are capable of filling without injury to themselves. He must have a general knowledge of safeguards, disagreeable or dangerous gases and dust frequently encountered in the shops, as well as heating, ventilation, locker rooms, rest rooms, shop restaurants, and some knowledge of housing, and recreational and educational features. He must also have some ability as a lecturer so that he can deliver talks to the employes on personal hygiene.

Cost of Health Supervision and Industrial Hospital Service

Figures compiled by the Conference Board of Industrial Physicians show that the cost of health supervision in the industries is much smaller than most employers who have not undertaken such work would be inclined to believe. Figures based on the experience of forty-one large plants in eleven industries, serving 223,416 employes show an average annual cost of $1.88 per employe. This includes the salaries of physicians and nurses and the cost of outside medical and surgical service. Of these plants, twenty-nine were in the metal trades, having 163,789 employes, and in these plants the average cost per employe was only $1.68 per year. The approximate cost of a complete hospital, equipped as shown in the accompanying illustration, would, at present prices, be about $7000.

Advantages of the Shop Hospital

It has been found in the shop hospital of the R. K. LeBlond Machine Tool Co. that the average time spent in the first treatment of each case, and in retreatments, is about twelve minutes. A great deal of this time is spent in a diplomatic effort to keep the patient in a good humor and make him feel more ready and happy to go back to his work than to go home after the pain has been soothed or the wound dressed. The efficiency of a shop hospital is based upon the doctor's ability to keep the men on the job.

In many cases where the patient requires medical attention, sometimes fifteen minutes or so spent in the rest room with a little skillful attention brings the patient back to normal. Men suffering from various acute ailments would ordinarily go home, but in nine cases out of ten they can be kept on the job if the hospital director understands his work. It should be understood that all cases treated in the shop hospital are of the emergency type, and no attempt is made to interfere with the family physician. This policy should be strictly adhered to in every shop hospital, because the primary object of the shop hospital should be preventive rather than curative, so far as medical efforts are concerned.

It is conservatively estimated that a man will lose a minimum of six hours going to and from his family physician, and some will not go who ought to go. It has been estimated that with a working force of 1000 there will be 12,000 visits made annually to an industrial hospital, for all conditions. Of this number it is fair to assume that in the absence of an industrial hospital, 3600 cases would require outside treatment. Since it has been ascertained that the average time lost in going to and from an outside physician is six hours,

it is fair to assume that the industry is saved approximately 21,600 hours or 2700 full working days, based on an eight-hour day.

The director of an industrial hospital can also prove of great help to the men employed by the advice and suggestions that he can make with regard to the employes' families. Many of the men take the doctor into their confidence and tell him of sickness or ailments of their relatives or dependents. The doctor investigates this, and in many instances this assistance proves very helpful to the men.

Records of the Activity of the Hospital

No shop hospital is complete without records. The details of those records are too voluminous for presentation in a mechanical journal, but the author of this article will be glad to send samples of the blanks used to any metal-working plant that is contemplating the installation of a shop hospital. These records can be kept up to date by a clerk devoting two hours a day to this work in a plant where one hundred patients a day receive treatment. The remainder of the day the services of the clerk can be utilized in the employment department or as a general assistant in the hospital, making gauze dressings, rolling bandages, and keeping the drug and store-room replenished.

Results Obtained by Shop Hospital

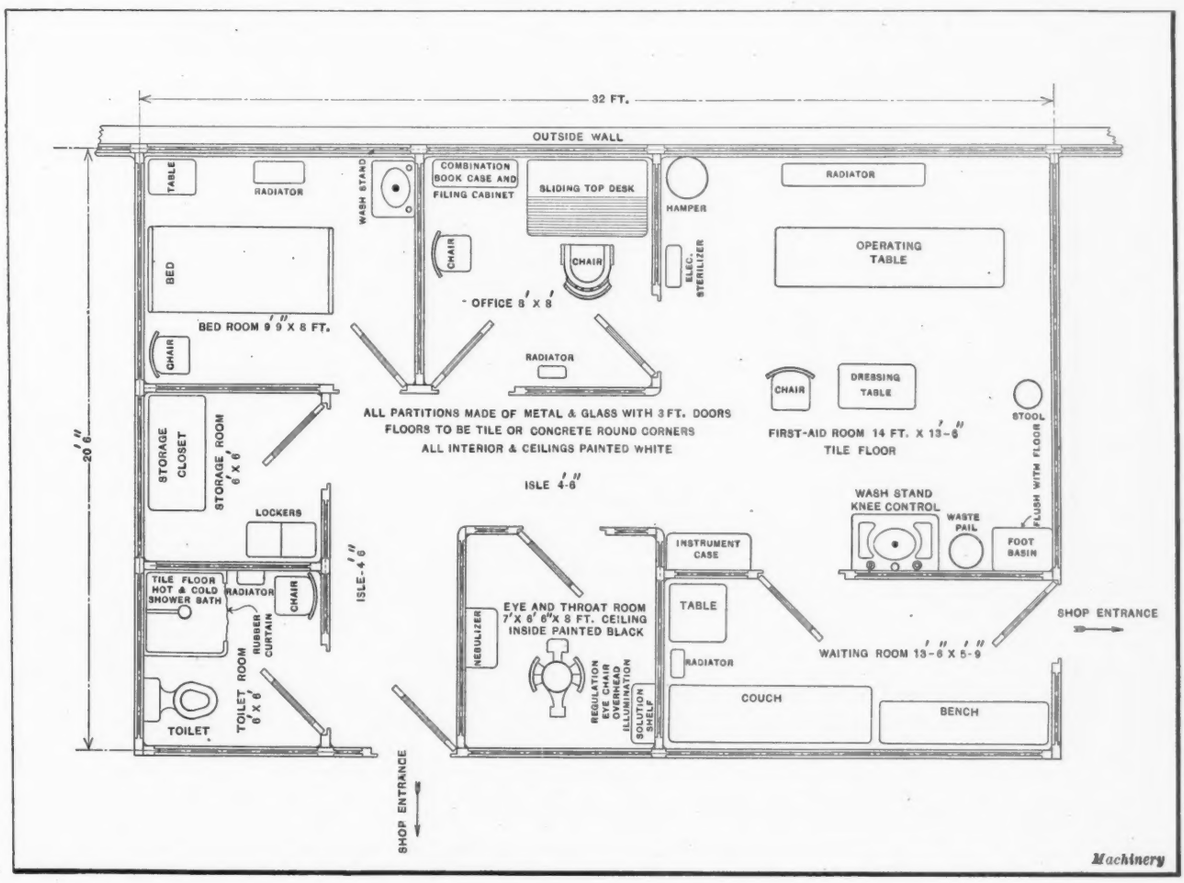
During the influenza epidemic of last year the medical work in the R. K. LeBlond Machine Tool Co.'s plant held the number of absentees down to 9 per cent of the working force during a period of three months, while several shops not equipped with an industrial hospital had an absentee rate of from 25 to 33 1/3 per cent, and one shop, 50 per cent. This shows the value of an industrial hospital, both in regard to preventive work among employes and results obtained from early treatment in case of sickness.

Last year, beginning with May 1 and ending September 30, an extensive campaign of accident prevention was inaugurated by the company. These months were selected because of the belief that fatigue is a prominent cause of accidents and that this cause would be present more frequently during the summer months. During the period, sixty hours were lost through injuries in the plant, and since about 1000 men were employed, this means an average loss of only 3.6 minutes per man for a period of five months. The company carries its own insurance, under the rulings of the Ohio Industrial Commission, but there was only $6.90 in compensation paid during the five months.

The Importance of Physical Examinations

Physical examinations of the applicants for employment should be an important part of the doctor's work. Benefits derived from physical examinations are shared by both the employes and the employers. A physical defect by no means prevents a man from being employed, but it does prevent him from being placed at work for which he is not fitted and which would become hard or dangerous to him because of his defect. Again, a physical examination often acquaints the person examined with some defects of which he did not know, and gives him an opportunity to take remedial measures. It also protects him from assuming undue risk of industrial accidents, if his physical condition is such as to invite injury. In a recent examination of 500 applicants between the ages of 16 and 62, it was found that of the 500 examined, 60 had defects that did not suit them for work requiring medium exertion of a somewhat hazardous nature.

Men suffering from attacks of heart trouble, for example, should not be employed at work where they may become frightened by sudden danger. There are cases on record where, due to accidental bursting of emery wheels, for example, men have died from heart failure because of fright, while they have been unharmed as far as being struck by pieces from the wheel was concerned. Large amounts of compensation have been paid to relatives of the unfortunate men in instances of this kind, under the compensation laws.



Floor Plan of Hospital at the R. K. LeBlond Machine Tool Co.

The shop hospital in which physical examinations are made can prevent the employment of men with such defects in any occupation that is likely to prove dangerous. There are so many occupations in any shop employing 1000 men that are not hazardous or that do not require great physical exertion, that men having some defects unfitting them for certain classes of work can be placed where the defects are of no importance.

As the doctor becomes familiar with the occupations in the plant, he is soon able to suggest placing men at the kind of work for which they are best fitted physically. He furthermore finds out what particular dangers are present in the plant and can cooperate with the engineering department for protective measures. The shop hospital is merely another link in the chain forged to create industrial efficiency. There can be no efficiency if the man employed to perform a certain task is physically unfit for the task assigned to him. It is the purpose of the shop hospital to select the men fitted for the work, and then to keep them fit.

* * *

The Engineering Foundation, created by an endowment of $300,000 from Ambrose Swasey of the Warner & Swasey Co., Cleveland, Ohio, past president and honorary member of the American Society of Mechanical Engineers, is seeking additions to this endowment with a view to raising it, if possible, to at least $1,000,000. Since 1915 the foundation has maintained cooperation in research between engineers and scientific workers, and the object of the foundation in building up the endowment fund is to make it of a size worthy of the engineering profession, as the results of this work will be approximately in proportion to the funds available. It is the purpose of the Engineering Foundation to stimulate, coordinate, and support research work in existing scientific laboratories, and to cooperate with the national research council. The foundation does not plan to build laboratories and conduct research work directly. The office of the foundation is in the Engineering Societies Building, 29 W. 39th St., New York City.

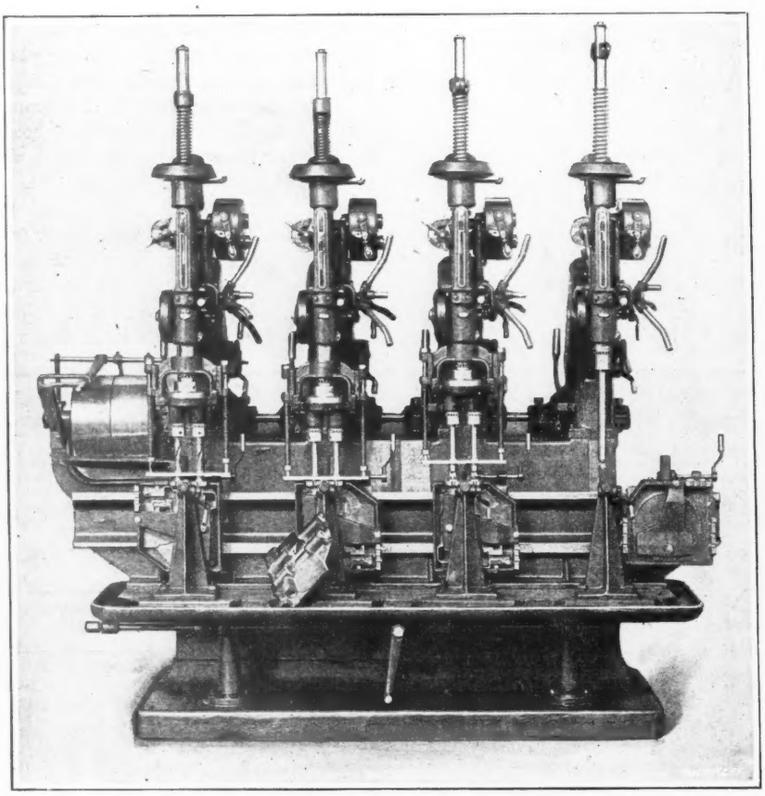
* * *

Vanadium steel is of comparatively recent origin. In a paper on ferro-vanadium, read by B. D. Saklatwalla of the Vanadium Corporation of America before the American Electrochemical Society, it was mentioned that until the discovery of a large deposit of vanadium in the Peruvian Andes in 1905, vanadium steel was not used to any great extent. In 1863, it was suggested by Lewis Thompson that vanadium might have an effect on iron similar to that of nickel. The first actual use of vanadium steel began in 1896, when it was experimented with for armor plates in France.

DRILLING MACHINE WITH SLIDING JIGS AND POSITIVE STOPS FOR RAPID PRODUCTION

The accompanying illustration shows a drilling machine built by the Barnes Drill Co., Rockford, Ill., which is used for drilling a number of holes in the body of the hydraulic gear-shifting device made by the United States Auto Gear Shift Co., Eau Claire, Wis. The holes are about one inch in diameter and are drilled from the solid, because it was found that better castings could be obtained when made solid than if the holes were cored. Absolutely sound castings are required on account of the fact that the mechanism is used for the hydraulic transmission of power.

In the first position, as shown at the left in the illustration, two holes are rough-drilled in one side of the casting. The jig in which the casting is held is then swiveled around, or indexed, and two holes in the bottom of the casting are drilled with the same drills. The guide bushings for the drills are part of the drill head, and are not attached to but fit into hardened bushings pressed in the swiveling jig. When indexing, a pull-pin is released by a lever shown at the right-hand side of the jigs at each drill spindle.



Multiple-spindle Drilling Machine equipped with Sliding Jigs

After the holes have been drilled, the jig slides along the rail to the second spindle, where the holes are rough-bored, using Kelly reamers. Two holes are first rough-bored on one side of the casting and then the casting is indexed around and the other two holes bored, the same as when drilling at the first spindle. The jig is then slid along to the third spindle, where the holes are finish-reamed in the same manner, and then the jig is moved along to the fourth spindle where all the holes are counterbored. In this case only one counterboring spindle is used and one hole is counterbored at a time, stops being provided to locate the jig accurately for each hole. The post shown at each spindle position, bolted to the table, is provided with a stop-pin that accurately locates the jig at each position. At the extreme left of the jig, in the position in which it is shown at the left-hand spindle, three notches will be seen at its edge. The center notch is used for locating the jig at the first three spindles, and the notches on each side are used one for each of the positions required when counterboring with the fourth spindle.

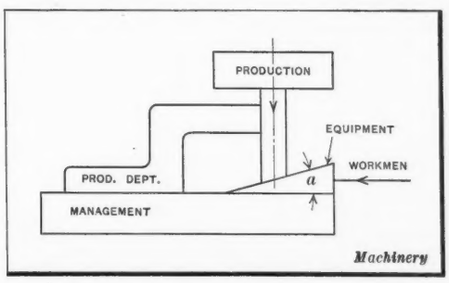
By the use of this machine it has been found possible to drill, bore, ream, and counterbore fifty hydraulic gear-shifter bodies per day. The machine is a 24-inch, four-spindle standard box-column all-geared gang drilling machine with coil springs and adjustable stop for automatic spindle return. Attention should be called to the design of the rail which is extended at each end of the machine for receiving and removing the work-carrier or jig.

FRICTION IN THE ORGANIZATION

By J. B. CONWAY

Perhaps the greatest obstacle to be contended with in an organization is friction. In the usual sense, friction implies disagreement between the employes, but when it applies to the functioning of an organization, it has a broader meaning than this. The word "friction" is defined as "resistance which a moving body meets with from the surface on which it moves." Friction acts opposite to and tends to retard the motion of a body. The body may be likened to production moving through a factory, the steady movement of which is dependent upon the proper functioning of the entire organization.

Under ideal conditions an organization, like a machine, would be one from which friction has been eliminated, but as this is an impossibility, it is desirable to reduce this factor to a minimum, just as the designer by the selection of proper materials and the application of various formulas reduces friction in the design and construction of a machine. The problem of reducing the factor of friction to the extent that it will not be objectionable in machine design is simple when compared with the task of modifying it in an organization. The reason for this is, of course, that the laws of mechanics, having been established after successful application for a long period, are better known than those applying to human nature. The laws of management are diversified, due to the human element involved. Laws governing finance, organization, departmental relations, employment, the movement of stock, selling policy, and financial returns on the investment are all well defined and, within certain limits, under the control of the management. A list of the most vital factors which produce friction in an organization would include insufficient funds, dissension, improper design of the product, improperly planned production, cost systems which tell only the profit and loss from one year to the next, strikes, breakdowns, delayed shipments, and labor turnover. Each of these factors tends to oppose the flow of production.



Graphic Presentation of the Relation of the Elements of an Organization as regards the Factor of Friction

Comparison between Mechanical Friction and that Found in an Organization

In the analogy between mechanical friction and friction in an organization, attention is directed to the accompanying illustration which shows graphically the application of this factor of friction to an industrial organization. The idea that the illustration is intended to show is that the workmen represent the power that exerts pressure on the wedge (equipment), which is supported by the management in raising the load (production), the latter being, in turn, supported or steadied by the production department. The friction between the load and the wedge is proportional to the load. In order to utilize this friction to advantage, the angle of inclination a should be such that it will sustain the load and at the same time prevent it from sliding by reason of its own weight. Any increase in the angle of inclination will result in a greater power requirement to raise the same load and will need more support from the production department. Conversely, a decrease in the angle will naturally result in lowering the production rate, unless greater man power is supplied. The angle of equipment is composed of such items as machines, prime movers, adequate stock, timely deliveries, cooperation, and all other factors entering into a modern organization. Each of these factors influences the angle and consequently affects all members of the mechanism.

The Coefficient of Friction in the Organization

It is evident that if the various factors involved in the functioning of the organization are known, the coefficient of friction can be easily obtained. For example, if in a 44-hour week, there is a loss of time due to delays to the equipment, or to tools for the equipment, assumed at 4.4 hours, the production week is 39.6 hours long, and if so desired these two factors, standard hours and production hours, may be plotted to show the time lost in percentage. This loss in the present case is 0.10 of the total time for the week, and may be considered as the coefficient of friction.

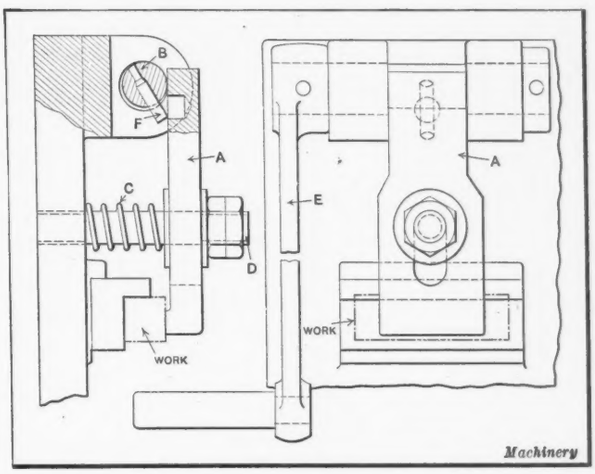
The writer has attempted to outline a graphic method of presenting the subject of efficient management, and has furnished merely enough information to convey the idea and enable the reader to work out his own method of applying it.

* * *

QUICK-ACTING CLAMP

By ROY V. TERRY

A quick double-acting clamp, the design of which may be adapted for use in fixtures where work having flat surfaces is to be clamped, is here illustrated. The operation of the clamp should be readily understood from the illustration. It will be seen that the clamping force is exerted through the medium of an eccentric cam B. This cam is operated by handle E and carries a drill-rod pin F. As the handle is raised, the cam pressure on strap A is released, so that as pin F engages a drilled hole in the strap, the latter will be carried back clear of the work. It will be observed that the release of the pressure and the removal of the strap are accomplished by a single motion of the operating handle. The strap should be guided between the cam bearings as well as on the stud D, so as to prevent it from turning on the stud. This stud carries adjusting nuts by means of which the amount of clamping pressure exerted on the work by the cam may be varied. The function of spring C is to keep the strap raised after the work has been removed so as to enable the fixture to be reloaded without difficulty.



Cam-operated Clamping Arrangement which may be incorporated in Fixture Design

* * *

That progress is being made in the industrial development of Brazil is indicated by an item in a recent commerce report, in which it is stated that an electric smelting plant having a capacity of 60 tons of steel daily is to be established in Sao Paulo.

The Production of Tool Steel

Processes Employed in the Steel Mill of the Ludlum Steel Co., Watervliet, N. Y., which is Engaged Exclusively in the Manufacture of Tool and Special Alloy Steels

By FRED R. DANIELS

THE average toolmaker and machinist, whose daily occupation brings him into contact with the uses of tool steel, is more familiar with what the steel can do than with how it is produced. He knows that steel possesses certain qualities, such as red-hardness, the ability to harden, ductility, toughness, etc., by virtue of the addition of carbon, nickel, chromium, cobalt, vanadium, and various other metals, but the results of the combination of these ingredients in the steel are only vaguely understood. This is not surprising, for the alloying of metals is a science in itself, regarding which metallurgists themselves have much yet to learn; the exact result that will be produced in a steel, for instance, by altering the percentages of the various components or by the addition of certain elements in varying quantities, is not fully understood even by scientists. While it is not the purpose of this article to discuss chemistry, nevertheless the chemical action which transpires in the melting furnace is predetermined by the metallurgist and is the greatest single factor in the success of the manufacture of tool steel.

Good tool steel can be manufactured by either the crucible process or by the electric furnace. The manufacture of tool steel requires almost the entire removal of such impurities as sulphur and phosphorus, the limitation of segregation in the molds, the reduction in the grain size, and any other item which may be classified under the refining process. The crucible process does not refine, but merely melts the charge. The advantage of the electric furnace method of manufacturing is that the steel is refined during the process of melting. This results in greater homogeneity in the ingot casting and in improving the microstructure of the steel, so that the refining process starts in the furnace. The result is that the high quality of the ingot steel poured from an electric furnace ladle is a decided advantage in the manufacture of alloy tool steel. Although high-grade tool steel can also be made in the open hearth, the process is a much slower one, and not as satisfactory when quantity production is concerned. The electric furnace is steadily supplanting all other processes in this industry. It is not merely by choosing the right process, however, that a high quality of the product is insured, but also by exercising the greatest care in every detail entering into the production. After the steel has been properly made in the furnace, a large amount may be ruined by casting it too hot or too cold or by using ingot molds of improper design.

The methods used by the Ludlum Steel Co., Watervliet, N. Y., will be described in this article, and some of the more interesting sides of the industry dealt with. Manufacturers of high-grade tool and alloy steels today are making detailed studies of their customers' individual requirements, and by using the information thus obtained, have made decided progress in the manufacture of steel, by furnishing the buyer with the quality which will meet the exact requirements of his product. The production of alloy steel is not different from that of structural or straight carbon steel, so far as the equipment is concerned, except for the use of an electric furnace. It is the methods employed and developed by the manufacturer engaged exclusively in the production of tool and special alloy steels which differentiate this industry from that found in steel mills where all kinds and grades of steel are manufactured.

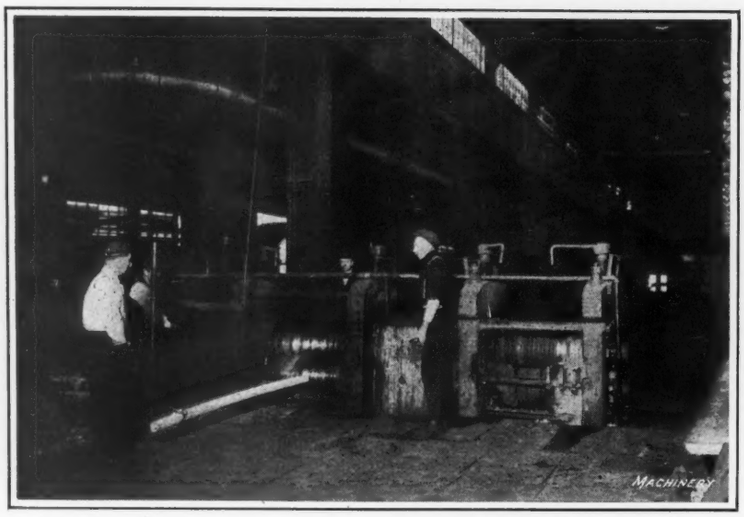


Fig. 1. View in the Bar Mill showing Two-high Stands for rolling Billets into Bars

The Melt Shop and Its Equipment

The crucible process may be defined as a remelting process, in which the crucible charge consists of either charcoal, refined or puddled iron, with suitable additions of carbon, manganese, alloys, etc., and as previously stated, the charge does not become refined. On account of the ability of the electric furnace to remove the undesirable metalloids, it is not necessary to use as high grade raw material as is required in the crucible. The raw material used is high-grade analyzed scrap, which at the Ludlum mill is deposited in huge concrete bins, located at one end of the melt shop in close proximity to the freight yard. An electric magnet crane is employed to transfer the scrap from the cars to the proper bins, each of which is suitably designated so that when preparing the scrap for the charge, raw material having a known amount of carbon, manganese, or other material can be selected. Preparatory to charging the furnace, the electric magnet crane drops the material on a scale in front of the furnace in quantities and proportions determined by the grade of steel to be made, and according to specifications prepared and furnished by the chemical laboratory.

Fig. 2. A Corner of the Chemical Laboratory in the Metallurgical Department, in which the Various Tests are made

Before proceeding further with the description of the melting process, a brief reference to the design of the Ludlum electric furnace will be made. The furnace is of the arc-resistance type and is furnished with three 9-inch diameter graphite electrodes about 6 feet long, which are arranged in the furnace roof in a straight line rather than triangularly, and which extend down into the oven of the furnace so that after the raw material has been added they may be lowered with their extremities resting on the charge, from which position they melt their way down to the bottom furnace lining where the first pool of molten material is produced. The shape of the furnace interior resembles a clam shell with the deepest portion directly under the electrodes. The advantage claimed for this design is that owing to there being no side walls to absorb heat and consequently reduce the temperature of the melt at the points that are farthest removed from the source of heat, a more even temperature is maintained throughout the molten mass. To assist in maintaining an even temperature, the shape of the roof is such as to radiate the heat into the melt increasingly as the distance from the center to the "horizon" increases.

The electrodes are supported in suitable overhanging arms, and means are provided for lowering or raising them as required. Provision is made in the design of these electrodes so that they may be entirely consumed. This is accomplished by making one end of the electrodes with a threaded shoulder and the other end tapped to receive a similar threaded shoulder. As an electrode burns down, it is simply necessary to screw a new electrode into the tapped hole of the one that is nearly consumed, with the result that a continuous electrode is obtained. The electrodes are consumed at the rate of about 2 inches per hour at the highest temperature, or about 10 inches for a heat of six hours' duration. In order to cool the top, the electrodes are surrounded with water jackets which are installed in the furnace roof.

The electric current is received from a three-phase transformer which delivers 90 volts of energy at 10,000 amperes to the furnace. The maximum temperature required is seldom greater than 2775 degrees F., this being the maximum heat for teeming or pouring the melt. The furnaces are lined with firebrick and magnesite or dolomite to a thickness of about 9 inches and are provided with two doors on opposite sides of the furnace, but have no pouring spout. Either one of these two doors may be used for charging, and the other is usually used when pouring, for the performance of which operation mechanical means are employed for tilting the furnace. The length of time required to complete a melt varies with the charge and may be anywhere from 3½ to 4 hours for straight carbon steel, to from between 4½ and 6 hours for high-speed and other alloy steels. This does not include the intermittent period be-

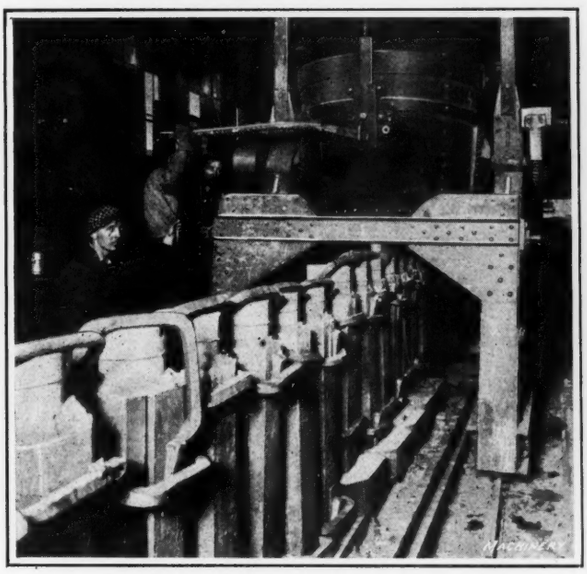


Fig. 3. View showing Row of Ingot Molds being poured and Track Carriage for supporting Ladle

Fig. 4. Reheating Furnaces of the Type employed for heating Ingots and Billets before cogging

Fig. 5. In the Warehouse the Bars are straightened before being prepared for Storage

tween melts which is required to patch the furnace lining and prepare to make the next charge. Three complete melts per twenty-four-hour day is about the average output of one furnace. After teeming, the lining is repaired, and as soon as practicable a new charge added. In the Ludlum mill one 10-ton and one 8-ton furnace are constantly at work night and day in the production of tool steel.

Charging the Furnace and Teeming

From the weighing scale, where the raw material has been deposited by the crane, the scrap is charged into the furnace, and after it has been reduced to the molten state, the previously mentioned refining process commences. As soon as this state has been reached, the melter covers the surface of the melted steel with a flux consisting of lime and fluor-spar for the purpose of producing a slag covering. This is known as the oxidizing slag and oxidizes out the impurities, such as phosphorus, sulphur, silicon, etc. Great care is exercised during this operation in regard to maintaining a definite temperature. The melter next rakes the slag off, and from its color and general appearance after it has cooled on the melter's stirring rod or rabbler, he judges the progress of the refinement. The proper stages of the melt are determined by the melter, who must be a highly skilled workman and whose knowledge in regard to this part of the industry is of the greatest importance. Obviously, pyrometers or other heat-measuring devices cannot be employed at such excessive temperatures.

If the condition of the melt is right, a second addition consisting of fluor-spar and silicon is made for the purpose of producing a reducing slag; that is, the oxides are reduced to their metallic state by the chemical action of the second silicious slag. This second slag is also removed, and is tested frequently during the process of refining, the results of these tests performed in the laboratory being furnished to the melter so that he may regulate the chemical content of the melt by the addition of carbon or other material or by the use of a third slag coating of lime and fluor-spar, if that should be required. Small iron molds are used for pouring the specimens which are to be analyzed during the melting process. Ordinarily, two slags are sufficient to produce the desired refinement.

After the necessary additions have been made in the melt, sufficient time must be allowed for the added alloys to mix thoroughly before the steel is ready to be teemed from the furnace to the ladle. The final slag is poured with the steel into the ladle, and acts as a blanket to keep the molten material at the proper temperature during pouring. Any increase in temperature above the necessary pouring heat, is made at the expense of the quality of the steel.

The ladle into which the steel is poured is supported on trunnions in a track frame under which a row of ingot molds is arranged between the tracks, as shown in Fig. 3 so that the ladle may be brought to the dead center of the mold during the pouring. The steel is bottom-poured, so that the slag will not be carried down with the metal. Since the bottom of the ingot mold is coned, by placing the nozzle of the ladle directly over the center, the splash that would otherwise occur at the bottom of the mold is eliminated. This is the ideal condition, as the mold is allowed to fill evenly and quietly. The "hot top," as may be seen by referring to Fig. 3, consists simply of a cylinder made of refractory material which is luted to the top of the mold. The hot top serves to keep the metal inside in a molten condition so that this acts as a feeder to the shrinkage cavity in the ingot caused by contraction of the metal as it cools, to the end that a more perfect ingot is produced.

One of the most serious objections to pouring the metal at too high a temperature is that a long time elapses before the metal will solidify and in this time crystals will form which have a tendency to throw off the various alloys. Alloys, as far as iron is concerned, are impurities, although some of these impurities are desirable and very valuable in the steel. In cooling, the tendency of the alloys is to segregate in the mold. If the cooling time is lessened, therefore, the degree of segregation will be reduced. Segregation also offers a means of ridding the steel of the impurities of phosphorus and sulphur, for under the proper pouring conditions this segregation can be confined to the top of the ingot which is subsequently cropped off in forging.

The forging department or hammer shop to which the ingots are delivered from the melt shop is equipped with specially designed coal-fired furnaces in which the ingots

Fig. 6. Grinding out the Seams, Laps, and Similar Surface Blemishes from the Tool-steel Bars

are reheated prior to forging. These furnaces are provided with pyrometer installation, which is rather unusual for reheating furnaces. The ingots are allowed to heat slowly and thoroughly to the correct forging temperature, which is predetermined in the laboratory, the specifications for each heat being furnished the furnace man so that exact results can be obtained and no guesswork resorted to.

The correct temperature, the speed at which the steel is heated, and the length of time that it is soaked all have a refining effect upon the steel, so that when it is placed under the hammer and carefully worked, the crystal sizes will be reduced to extreme smallness. The smaller the crystal size, the higher the refinement in the steel. This forging down to such sizes as can be conveniently handled in the rolling mill must be carefully done, as otherwise the steel may easily be ruined. The pressure to which the steel is subjected under the hammer must be applied at right angles to the face of the hammer, and the contact under the hammer head and on the anvil must be on a line parallel to the axis of the hammer; otherwise a shearing action will occur which will cause the center to become fractured.

Fig. 7. Surface Defects are removed from Carbon Steels by the Use of a Pneumatic Chipping Tool

This first mechanical reduction in the ingot produces what is known in the steel mill as a "bloom" or "billet." In working the ingot down it must be kept in square form during the reduction process, and then if the final bar is to be hexagonal, circular, or some other shape, this shape is produced after the approximate size has been attained. If the forging of ingots into billets of shapes other than square started by producing the desired shape at first, the bar would have a split center. Here is another phase of the tool steel industry in which the highest degree of workmanship is essential. The almost perfect shapes that can be produced by simply hammering are a testimonial to this fact. The writer noticed a circular bar 8 inches in diameter and about 8 feet long which had been produced in this manner from an ingot. This bar was very straight and was practically perfect as regards roundness, and on the surface the hammer marks were barely perceptible. The equipment of the hammer shop comprises single- and double-frame steam hammers of various capacities, the largest size being 12,000 pounds.

Cogging, Inspecting, and Annealing

The reheating furnaces in the rolling mill are of the same general design and are operated under the same general conditions as those in the hammer shop. A battery of these furnaces is shown in Fig. 4. The reduction of the billets in the rolling mill and of the resulting bars in the bar mill, Fig. 1, is the same as the process employed in other steel mills, and for that reason will not be described. Before the billets are reheated in the rolling mill furnace, they are inspected for seams, blemishes, laps, and similar surface defects which are either chipped or ground out so that in cogging, these imperfections will not be rolled still farther into the bar.

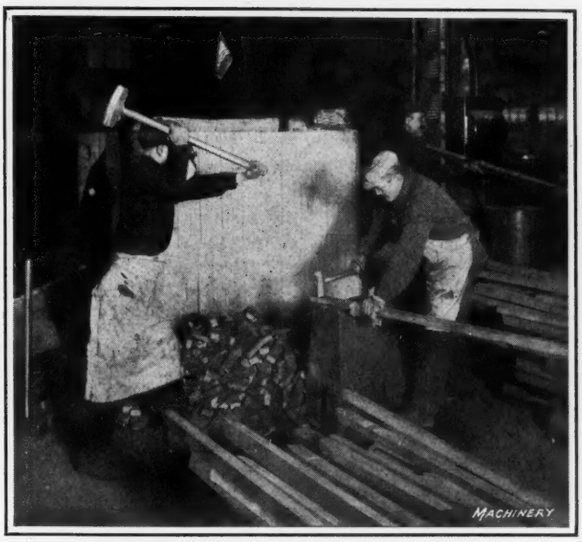


Fig. 8. Tapping the Bars preparatory to inspecting the Fracture

There is one feature in the cogging mill, however, which is deserving of especial attention, and that is the checking of the finishing temperature by an inspector by means of an optical pyrometer. By "finishing temperature" is meant the temperature of the billet or bar after having passed through one entire reduction process, for instance, having passed through the 18-inch cogging mill. Between each series of cogging rolls, the same procedure occurs, that is, the elongated bars caused by reducing the area are cropped to suitable lengths and reheated in furnaces such as are illustrated in Fig. 4. A pile of these cropped bars is shown lying near the reheating furnaces. Surface defects may show up at any stage, and they are diligently looked for and removed. Figs. 6 and 7 show the methods employed in removing these defects, Fig. 7 showing the use of the pneumatic chipping tool on carbon steel, and Fig. 6 the process employed in removing the defects from high-speed and other alloy steel by grinding. The grinding wheel carriage has a telescopic tube connection with the machine, whereby the grindings are carried away by means of a blower, and an arrangement for swinging the position of the grinding wheel as desired. Every bar that has any indication of a surface flaw is subjected to this grinding or chipping treatment, for the most minute surface defect is often indicative of a more serious defect.

After the steel has been reduced to the desired size, it is sent to the final inspection department where a fracture is taken of every bar and each bar is inspected for mechanical faults, such as seams, cracks, and general imperfections. Fig. 8 shows how each bar is tapped so as to enable a visual inspection of the ends of the bar to be made. If a bar does not meet the requirements when thus inspected it is cut into scrap and remelted. This department is furnished with suitable straightening machines (Fig. 5), and after the steel has passed through the rolls of these machines it is ready to be weighed, coated with rust preventive, painted with suitable identification numbers, bundled and shipped, or else sent to the annealing department, for practically all tool steel is annealed before being finally shipped.

Oil furnaces are used in the annealing department on account of the more even heat that can be obtained with this fuel. The furnaces are of the car-bottom type, and are equipped with Wilson-Maeulen pyrometers. The bars are packed in charcoal ashes in long, cylindrical tubes which are sealed or luted with fireclay and loaded on the flat car which forms the bottom of the furnace. The loaded car is then rolled into the furnace and the temperature raised to the required degree.

The procedure in the annealing department is like that in other departments of this mill in that it is furnished with specifications from the laboratory regarding the furnace regulations. The annealing process for alloy steel is not necessarily a straight slow cooling process, and each steel of different analysis is provided with carefully determined instructions which the man in charge of the furnaces is required to follow. He must drop the temperature an exact number of degrees per hour between certain temperatures, the determination of which for each different analysis of steel is arrived at after careful research work in the laboratory. In this way only, is a satisfactory anneal accomplished.

The annealed stock is then sent back to the warehouse, where after being examined and straightened it is prepared for final shipment in the same way that the unannealed stock was handled. This latter work is taken care of by the shipping department.

Those who are familiar with the manufacture of steel will not recognize any new procedure included in this description, but will no doubt realize that in handling alloy steel in the electric furnace and in the other refining processes a great deal more individual attention is given to each lot of steel that passes through than would be the case under ordinary conditions. For instance, the pyrometer installation in the reheating furnaces, the use of the optical pyrometer at the end of each cogging reduction, the exactness attendant upon the removal of surface imperfections, and the great amount of detail entering into the annealing process, all tend to accentuate the statement that it is the details employed and not the special appliances that differentiate the manufacture of the ordinary machine, structural, and mild steels from the manufacture of high-grade refined tool and special alloy steel.

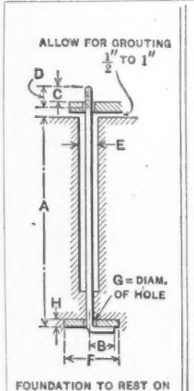
* * *

FOUNDATION BOLT DIMENSIONS

By EDWARD W. THEILIG

Supplementary to the article "Fastening Machines to Concrete Floors and Foundations," which appeared on page 820 of the May number of MACHINERY, the dimensions relative to setting foundation bolts given in the accompanying table may prove valuable. It will be noted that for bolts 2 inches or over in diameter, a nut is used under the washer or anchor plate instead of the bolt being clinched, as indicated by dimension *B*.

STANDARD DIMENSIONS FOR SETTING FOUNDATION BOLTS (Inches)



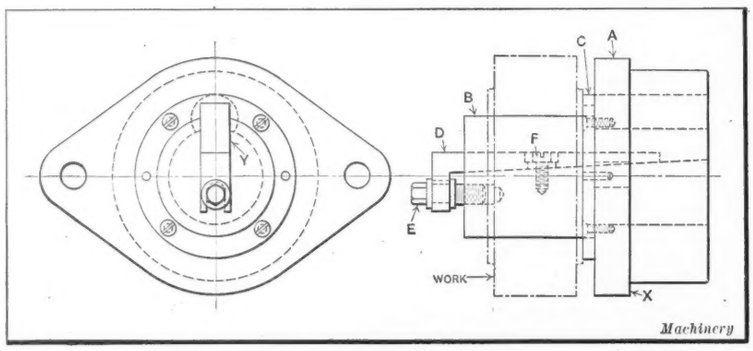
Bolts						Washers		
Dia.	A	B	C	D	E	F	G	H
¼	..	...	...	...	..	.....	...	...
⅜	..	...	...	...	..	.....	...	...
½	12	2½	¾	1	2	5 by 5	⅞	⅝
⅝	15	2½	1	1¼	2	5 by 5	⅞	⅝
¾	18	2½	1⅛	1½	3	5 by 5	⅞	⅝
⅞	21	3	1⅜	1¾	3	6 by 6	1¼	¾
1	24	3	1½	2	3	6 by 6	1¼	¾
1⅛	27	4	1¾	2¼	4	8 by 8	1⅝	1
1¼	30	4	1⅞	2½	4	8 by 8	1⅝	1
1½	36	5	2¼	3	4	10 by 10	2	1¼
1¾	42	5	2⅝	3½	5	10 by 10	2	1¼
2	48	Nut	3	4	5	12 by 15	2¼	1
2¼	54	Nut	3⅜	4½	6	12 by 15	2¼	1
2½	60	Nut	3¾	5	6	12 by 20	3	1½

Machinery

WORK-HOLDING FIXTURE FOR BROACHING MACHINE

By F. WILLIAM STEIN

The accompanying illustration shows a fixture designed for holding work on a broaching machine when cutting a single keyway in a part. A feature of this design is that the broach can be readily readjusted after it has been removed for grinding. The cast-iron part *A* is bolted to the faceplate of the broaching machine, surface *X* being in contact with the front of the faceplate. The work, which is indicated by dot-and-dash lines, is mounted on the steel broach guide *B*, which is a press fit in part *A*. In this guide is a slot *Y* in which the broach operates. The bottom surface of the slot is tapered to correspond with the taper surface on the adjusting wedge *D*. This wedge is clamped to guide *B* by means of a fillister-head machine screw *F*. The head and a portion of the body of this screw are contained in a counterbored elongated slot in the wedge, which permits a certain amount of longitudinal movement of the wedge when the collar-head screw *E* is turned.



Broaching Machine Work-holding Fixture which permits Vertical Adjustment of Broach

When this movement of the wedge takes place, the position of the upper surface of the wedge is altered slightly, because of the taper of its bottom surface. Therefore, as the bottom of the broach rests upon the upper surface of the wedge, this arrangement permits a vertical adjustment of the broach. The screw *F* must be loosened, of course, before making an adjustment, and retightened after the adjustment has been accomplished. The clearance hole for the broach in part *A* is comparatively large, and so a steel washer *C* is provided to furnish a backing for the work when broaching work made of a soft metal. This washer is attached to part *A* by means of dowel-pins and flat-head machine screws and has a slot in it that slightly clears the teeth and sides of the broach. The surface on guide *B* upon which the work is mounted is hardened and ground to suit the hole in the work, while the surfaces of slot *Y* are hardened and ground to suit the broach. Washer *C* and adjusting wedge *D* are also hardened and ground.

* * *

The volume of aluminum castings, especially those containing copper, may be permanently changed by heat-treatment. Their degree of hardness may also be changed. These facts are considered when heat-treating aluminum parts such as pistons, which are intended for operation at a high temperature. The pistons are generally given a heat-treatment which will cause a permanent change in the volume to such an extent that no additional change will occur when running.

MACHINE SHOP EQUIPMENT FOR TRADE SCHOOLS

A question that is often asked by those who are responsible for the equipment of trade schools or technical high schools is, "What equipment is most suitable and how much equipment is required?" This question has been answered by a booklet published by the South Bend Lathe Works, South Bend, Ind., and copyrighted by J. J. O'Brien and M. W. O'Brien. From the information contained, the accompanying table of standard trade school equipment has been compiled. Five different equipments are given, because the size of the equipment for any one school depends upon the number of boys that are to be trained. Equipment No. 1, suitable for a small school shop, would cost only from $800 to $1000 at present prices. The other equipments would cost correspondingly more; for instance, equipment No. 5, for a school with ninety boys, would cost from $15,000 to $18,000.

STANDARD TRADE SCHOOL EQUIPMENT

Equipment No. 1—Cost, $800 to $1000 Suitable for Small School Shop

1 engine lathe, 15-inch swing, 6-foot bed
1 tool-room grinder, 8 by ¾ inch, with column
1 electric motor, 2 horsepower
10 feet of shafting, 1 15/16 inches; 2 hangers, belting, and pulleys
1 independent four-jaw chuck, 8-inch
1 straight turning tool
1 right-hand turning tool
1 left-hand turning tool
1 right-hand side tool
1 left-hand side tool
1 straight cut-off tool
1 threading tool
1 drill chuck, 0 to ¾ inch
1 set of straight-shank twist drills, 1/16 to ¾ inch in sixteenths
1 vise, 4½-inch jaws
1 adjustable hand hacksaw frame, 10-inch
1 ball-peen machinist's hammer, 1½ pounds
6 files, assorted
1 ¾-inch lathe dog
1 1¼-inch lathe dog
1 2-inch lathe dog

Equipment No. 2—Cost, $1200 to $1500 Suitable for Vocational School Machine Shop with 24 Boys in Vocational or Industrial School Course

2 engine lathes, 15-inch swing, 6-foot bed
1 back-gear power-feed drilling machine, 20-inch
1 tool grinder, 8 by ¾ inch, with column and water pot
1 power hacksaw
1 electric motor, 3 horsepower
20 feet of shafting, 1 15/16 inches; 4 hangers, belting (double ply) and pulleys
1 independent, four-jaw 10-inch chuck (reversible jaws)
1 universal, three-jaw 8-inch chuck (reversible jaws)
2 straight turning tools
2 right-hand turning tools
2 left-hand turning tools
2 right-hand side tools
1 left-hand side tool
1 straight cut-off tool
1 right-hand cut-off tool
1 threading tool
1 small boring tool
1 large boring tool
1 drill chuck, 0 to ¾ inch
1 set of straight-shank twist drills, 1/16 to ¾ inch in thirty-seconds
1 vise, 4½-inch jaws
1 adjustable hand hacksaw frame, 12-inch
2 ball-peen machinist's hammers, 1½ pounds
1 ball-peen machinist's hammer, 12 ounces
12 files, assorted
2 ¾-inch lathe dogs
2 1¼-inch lathe dogs
2 2-inch lathe dogs

Equipment No. 3—Cost, $3000 to $3500 Suitable for Vocational School Machine Shop with 44 Boys

4 engine lathes, 15-inch swing, 6-foot bed
1 metal-working shaper, 14-inch (swivel vise)
1 back-gear power-feed drilling machine, 20-inch
1 sensitive drilling machine, 15-inch
1 tool grinder, 12-inch
1 power hacksaw
1 electric motor, 5 horsepower
20 feet of shafting, 1 15/16 inches; 4 hangers, belting (double ply) and pulleys
4 independent, four-jaw 10-inch chucks (reversible jaws)
1 universal three-jaw 9-inch chuck (2 sets of jaws)
5 straight turning tools
4 each, right-hand and left-hand side tools
3 right-hand cut-off tools
2 straight cut-off tools
2 each, small and large boring tools
1 drill chuck, 0 to ½ inch
1 drill chuck, 0 to ¾ inch
1 set of straight-shank twist drills, 1/32 to 1 inch in thirty-seconds
2 vises, 4½-inch jaws (swivel)
1 vise, 5-inch jaws
1 adjustable hand hacksaw frame, 10-inch
4 ball-peen machinist's hammers, 1½ pounds
1 cross-peen machinist's hammer, 1½ pounds
1 straight-peen machinist's hammer, 1½ pounds
1 ball-peen machinist's hammer, 12 ounces
12 files, assorted
1 set of lathe dogs, ⅜ inch to 2 inches

Equipment No. 4—Cost, $8000 to $10,000 Suitable for Shop with 66 Boys

6 engine lathes, 15-inch swing, 6-foot bed
1 metal shaper, 16-inch (swivel vise)
1 universal milling machine, No. 1
1 metal planer, 24-inch by 24-inch by 6-foot, with 18-inch planer chuck
1 back-gear power-feed drilling machine, 20-inch
1 sensitive drilling machine, 15-inch
1 power hacksaw No. 1
1 tool grinder, 12-inch
1 electric motor, 10 horsepower
28 feet of shafting, 1 15/16 inches; hangers, couplings, pulleys, and belt (double ply)
6 independent four-jaw 10-inch chucks (reversible jaws)
1 universal three-jaw 9-inch chuck (2 sets of jaws)
14 turning tools (8 straight, 4 left-hand, and 2 right-hand)
9 cutting-off tools (4 straight, 3 right-hand, and 2 left-hand)
6 side tools (4 right-hand and 2 left-hand)
2 each, small and large boring tools
1 drill chuck, 0 to ½ inch
1 drill chuck, 0 to ¾ inch
1 set of straight-shank twist drills, 1/32 to 1 inch in thirty-seconds
1 set of drills, No. 0 to No. 60
4 vises, 4½-inch jaws
1 vise, 5½-inch jaws
2 hacksaws, 10-inch
6 ball-peen machinist's hammers, 1½ pounds
2 cross-peen machinist's hammers, 1½ pounds
1 straight-peen machinist's hammer, 1½ pounds
2 straight-peen machinist's hammers, 12 ounces
1 set of lathe dogs, ⅜ inch to 2 inches

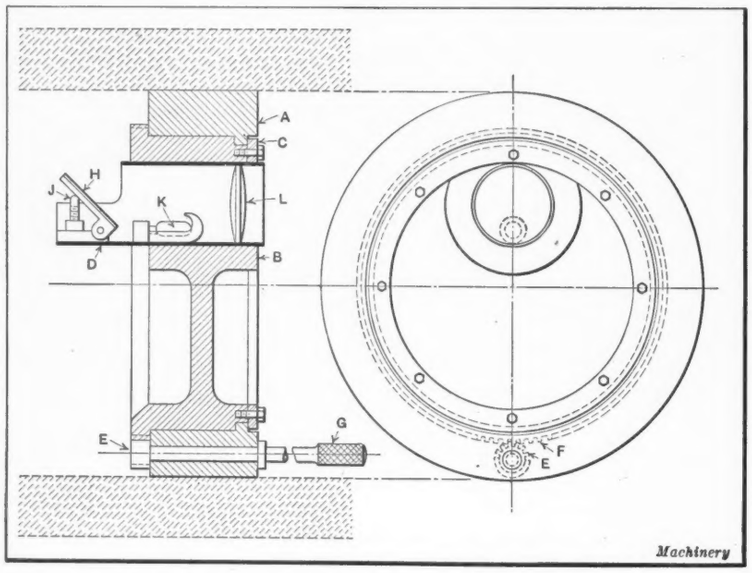
Equipment No. 5—Cost, $15,000 to $18,000 Suitable for Shop with 90 Boys

10 engine lathes, 15-inch swing, 6-foot bed
2 engine lathes, 18-inch swing, 8-foot bed
1 planer 24-inch by 24-inch by 6-foot with chuck (swivel base)
1 universal milling machine with vertical attachment
1 universal grinding machine
1 shaper, 15-inch (swivel base vise)
1 back-gear power-feed drilling machine, 20-inch
1 combination and dry tool grinder, 14-inch
1 sensitive drilling machine, 15-inch
1 arbor press
1 power hacksaw
64 feet of shafting, 1 15/16 inches; couplings, hangers, pulleys, and belting (double ply)
1 electric motor, 15 horsepower
10 independent four-jaw, 10-inch chucks
2 independent four-jaw 12-inch chucks
3 universal three-jaw 9-inch chucks
21 turning tools (12 straight, 6 left-hand, and 3 right-hand)
12 side tools (10 right-hand and 2 left-hand)
11 cut-off tools (8 straight and 3 right-hand)
3 threading tools
2 each, small and large boring tools
1 knurling tool
1 set of lathe dogs, ⅜ to 2 inches
10 ball-peen machinist's hammers, 1½ pounds
2 cross-peen machinist's hammers, 1½ pounds
2 straight-peen machinist's hammers, 1½ pounds
4 straight-peen machinist's hammers, 12 ounces
1 drill chuck, 0 to ½ inch
1 drill chuck, 0 to ¾ inch
1 set of straight-shank twist drills, 1/32 to 1¼ inches in thirty-seconds
1 set of drills, No. 0 to No. 60
1 drilling machine vise
6 vises, 4¼-inch jaws
2 hacksaw frames, 10-inch
24 files, assorted
1 planer tool
1 set of horizontal milling cutters
1 set of vertical milling cutters

REFLECTING DEVICE FOR INSPECTING BORES

By L. E. OLSEN

The reflecting instrument illustrated, while primarily developed for use in inspecting the bores of guns, may be used with equal advantage for examining the interior of any cylindrical work, where a visual inspection of the walls is desired. This reflecting device was developed by Major R. Cockburn while engaged on ordnance inspection work in France.



Instrument used in examining Interior Cylindrical Walls, such as Gun Bores

The reflector consists of a tube *D* in which, at one end, is mounted a bi-convex lens *L*. The opposite end of the tube is cut away as shown, and has mounted within it a mirror *H* which can be adjusted, by means of screw *J*, to the desired angular position. Midway between the mirror and the lens is an electric lamp *K*, its position being such as to illuminate portions of the wall, or bore, so as to bring them into direct observation. When the device is used on large-diameter work, the tube is carried in a spider *B* which may be revolved in drum *A*. This drum may be made to suit the diameter of the work being inspected, and is provided with the plate *C* which is attached to the spider by means of screws for the purpose of holding the parts together. The flange on the inner side of the spider has gear teeth cut in it, which engage pinion *E* carried on handle *G*. The operating handle may, of course, be extended to suit the length of the bore being inspected. It will be seen that the instrument can be adjusted longitudinally in the bore; also, by revolving spider *B* the wall may be observed from any angular position, both adjustments being made by means of the operating handle. When used on cylindrical work over 200 inches in length, no difficulty is experienced in discerning any portion of the wall, but for work which is longer than this a pair of binoculars should be used in connection with the reflector.

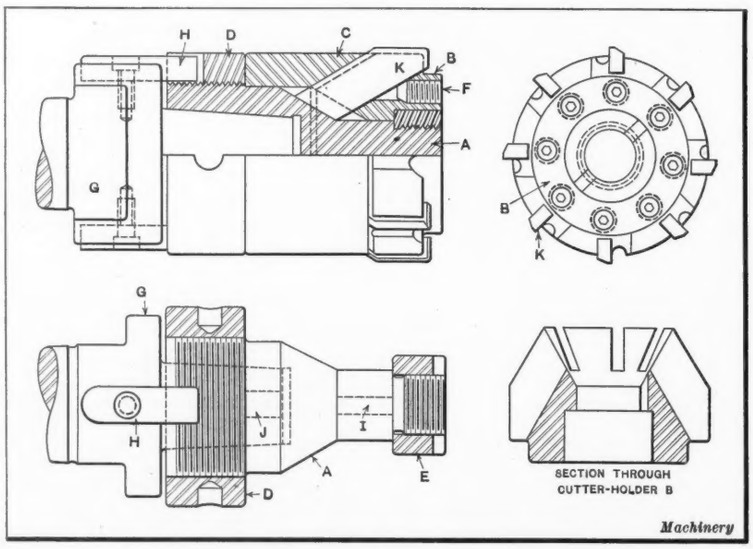
It has previously been mentioned that an instrument of this kind is especially valuable for inspecting gun bores. The need of such an instrument will be more fully appreciated when it is stated that erosion manifests itself in guns by the hardening and cracking of the rifled surfaces, as well as by the formation of pockets. The result is disastrous to the effectiveness of the gun. The bore also becomes enlarged so that the projectile does not fit tightly, with the result that the gases generated by the explosion escape between the projectile and the surface of the bore, and do not exert the contemplated pressure. A surprisingly low number of rounds is required to place a gun in a condemned or non-dependent stage; for example, a 75-millimeter gun is condemned at 1000 rounds, and as the size of the gun increases the length of life decreases so that a 406-millimeter howitzer is not dependable after 83 rounds. From data such as this, it is found that the active life of a 75-millimeter gun is only about 25 seconds. It may be of interest to note that the 381-millimeter German gun which was used in the recent war could not be used for more than 30 rounds.

* * *

ADJUSTABLE BORING HEAD OR REAMER

By FRANCIS CONDIE

The boring head or reamer here described was developed by the writer for boring gasoline engine cylinders and is slightly different in design from the usual type. This tool may be inexpensively made, and its cost of upkeep is correspondingly low. It may be made either integral with the shank or separable, as desired. The illustration shows a part-sectional assembly view of the tool, a view of the tool with the cutter-holder and the cutters removed, as well as a section through cutter-holder *B*. A description of the method of adjusting the tool should not be necessary. The main body *A* carries two adjusting nuts *D* and *E*, threaded to it, as shown in the lower part of the illustration. The backing-up collar *C* fits over the body *A* and bears against nut *D* so as to support the individual inserted steel blades *K*. These blades are adjustable in slots in the cutter-holder *B* in which they fit, each being secured in its respective slot by means of a set-screw *F*. The cutter-holder *B* and the backing-up collar *C* are prevented from rotating by means of the keys *I* and *J*. If the reamer is not made integral with the shank, it may be driven by means of two dogs *H* which are attached to the shank *G*, and which engage suitable slots in the nut *D*. All the parts of this tool, except the cutter blades, should be made of machine steel, pack-hardened and ground all over. The blades, which preferably should be made of stellite or high-speed alloy steel, should be ground all over and made a sliding fit in the slots of the holder.



Special Tool used in boring Gasoline Engine Cylinders

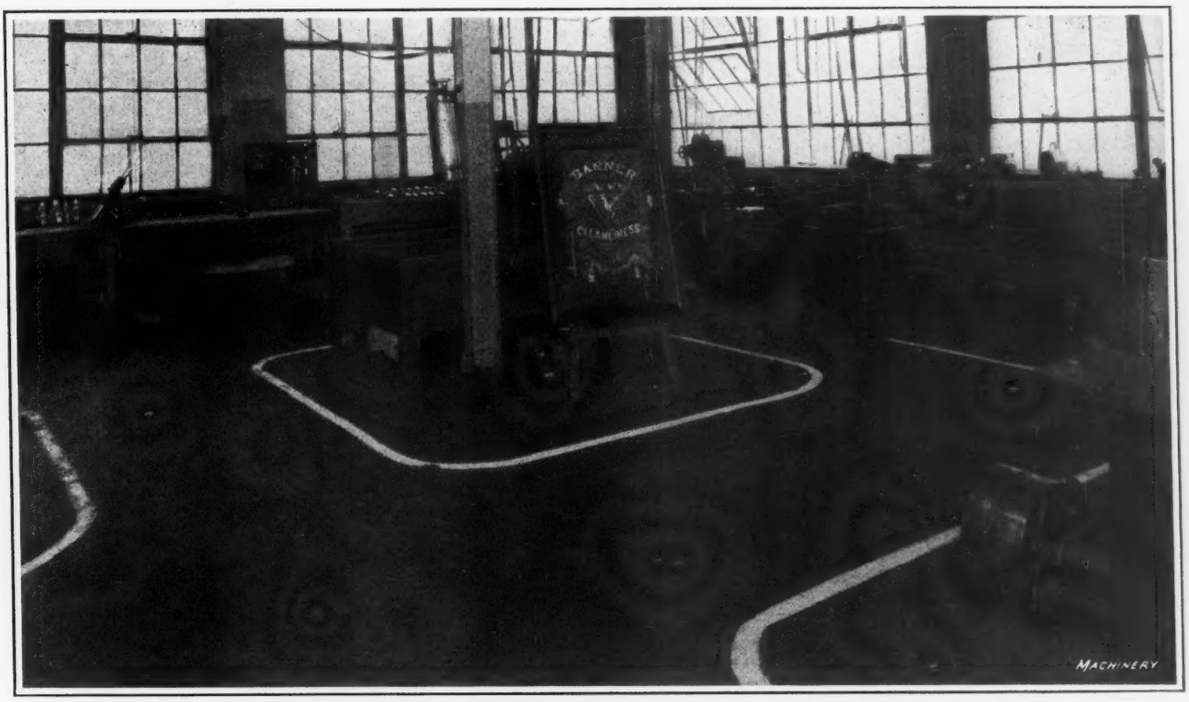


Fig. 1. Banner which remains for One Month in the Department receiving the Highest Rating for Cleanliness

Encouraging Cleanliness in the Factory

System Adopted by the Timken-Detroit Axle Co., Detroit, Mich., for Promoting Cleanliness and Efficiency

AT the plant of the Timken-Detroit Axle Co., Detroit, Mich., a campaign has recently been inaugurated to encourage foremen to keep their departments neat and clean. A superficial consideration of the subject might lead to the conclusion that this is not a factor that vitally affects efficiency in manufacturing; but since the records of foremen whose departments have been found in the best condition by inspectors who conduct a monthly investigation have been available for comparison with the records of foremen whose departments have reached the highest efficiency in manufacturing, it is noteworthy that the men who have been getting out the greatest amount of work with the least quantity of spoiled parts are those who also keep their departments the cleanest and in the most presentable condition throughout.

There are two competitions constantly in progress in the Timken plant in which all foremen are competitors. The awards for one competition are made to the two men whose departments are found to be in the most orderly condition, and the awards in the other competition are based upon the degree of efficiency attained in the performance of manufacturing operations. Each award is made monthly. For cleanliness, there are two trophies which circulate from department to department and remain for the month following their award. The first prize is a banner, shown in Fig. 1, and the second award is a shell, illustrated in Fig. 2. The name of the department foreman is engraved on the shell opposite the month for which it remained in his section of the plant; and a shell of exactly the same design remains permanently in the office of the general superintendent.

Fundamentally, this campaign to encourage cleanliness was inaugurated with a view to improving conditions that have a direct bearing upon the efficiency with which manufacturing operations can be performed or those which affect the health of the operatives. For instance, it was the aim to see that aisle spaces were kept clear to facilitate efficiency in trucking, but the scope of this work has now been extended to a point where the inspectors in conducting their monthly investigations take into account such points as the presence of unused clothing hanging on the walls or posts; the presence of dirty rags, old gloves, etc., on benches or window sills; the cleanness of the windows and all similar conditions. Special blanks are provided for the inspectors' reports.

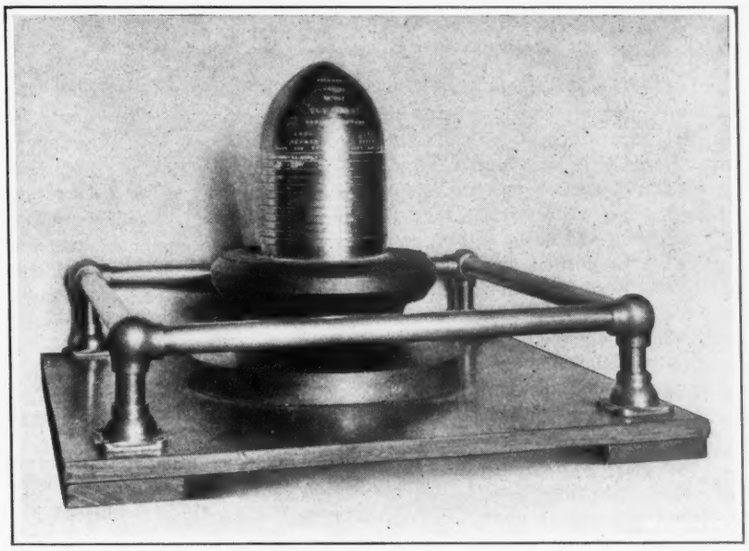


Fig. 2. Shell which remains for One Month in the Department receiving Second Highest Rating for Cleanliness

For the competition for efficiency attained in the performance of manufacturing operations there is another shell which remains in the office of the factory manager, the names of the foremen winning this prize being engraved month by month, as in the case of the shell which is awarded for cleanliness. Each foreman in the plant is also awarded a bonus on his regular rate of pay, which is based upon the manufacturing efficiency that is attained by his department, the method by which the bonus is calculated being as follows: The normal rate of production is fixed at 600 sets of axles per day, and for an output equal to 80 per cent of this standard the foreman receives a bonus of 0.5 per cent, the bonus increasing uniformly from that figure up to 30 per cent of his pay for the attainment of an efficiency of 100 per cent of the normal rate of output. Thus, for each 1 per cent increase in efficiency from 80 up to 100 per cent of the plant's normal capacity, the foreman receives a bonus of 1½ per cent of his wages. For each 1 per cent of increased efficiency over 100 per cent of the normal plant capacity, the bonus rate is 2 per cent, so that for a production of 900 axles per day, which is 50 per cent over the normal rate of output, the foreman would receive a 100 per cent bonus on his wages.

In connection with this bonus plan an effort is made to impress upon foremen the vital importance of reducing the spoilage of parts to a minimum, and with that idea in mind, deductions are made from each foreman's bonus credit for an excessive amount of spoiled work. The normal rate of spoiled work is fixed at 2 per cent of the daily output, and for each 0.5 per cent in excess of the normal rate, a deduction of 1 per cent is made from the foreman's efficiency record and, consequently, from his credit for the special bonus. It will be apparent from the preceding discussion that the foreman who earns the highest bonus for the month is also the man who has his name engraved on the shell which remains in the office of the factory manager.

* * *

Good electrolytic copper, according to the *Scientific American*, should have approximately the following analysis: Copper, 99.95; silver, 0.001; oxygen, 0.039; sulphur, 0.003; arsenic, 0.0015; antimony, 0.0020; nickel, 0.0015; iron, 0.0025; lead and bismuth, none; selenium and tellurium, trace.

ANDREWS RUSTPROOFING PROCESS

To provide for the rustproofing of ferrous metals in order that they may be used as a substitute for copper, brass, bronze, etc., a process has been introduced into this country by the Andrews Rustproofing Laboratories with offices at 821 Book Bldg., Detroit, Mich., which was successfully used by British munition plants for protecting cast-iron fuse bodies during the last two years of the war. This process is applied by subjecting the work to a temperature of from 1150 to 1180 degrees F. in the presence of an oxidizing atmosphere, which results in opening the pores of the metal and sealing them with a layer of iron oxide. It is stated that the process was used by the British Government under conditions which thoroughly proved that it does not distort the work nor alter its dimensions. As a result of this feature, the Andrews rustproofing process can be used for protecting the surfaces of threaded work and similar parts which will later be required to assemble with corresponding close-fitting parts. On a production of over 100,000 fuse bodies rustproofed in March, 1918, there was less than 2 per cent of rejections for distortion which is a remarkably low average, bearing in mind the close limits that were required on these parts. This method of rustproofing applies a rich ebony-colored finish, which is of pleasing appearance and is said to be permanent as regards durability. The cost of operation is low, as unskilled labor may be utilized after the furnaces have been regulated and the burners sealed to assure operation under specified conditions that are adapted for the work in hand. An idea of the low cost at which parts can be rustproofed by this process will be gathered from the fact that the cost of rustproofing one type of parts weighing 2½ pounds was only ½ cent.

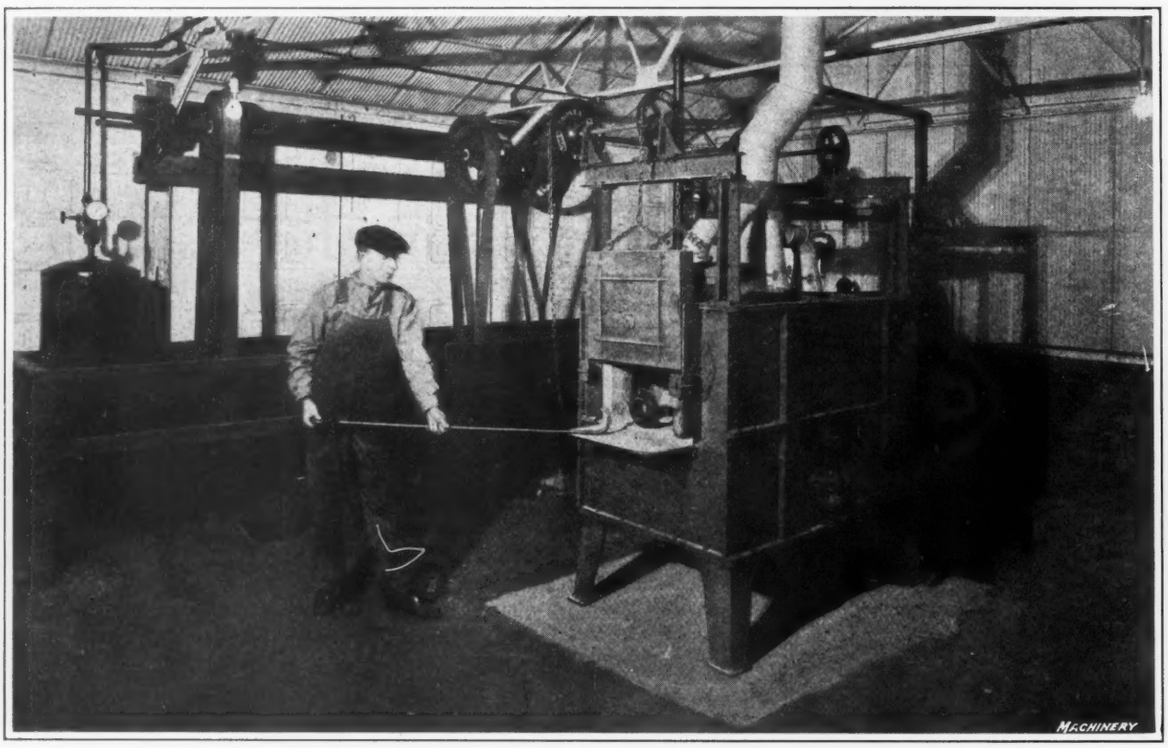


Fig. 1. Furnace used for rustproofing by the Andrews Process

How the Method is Applied

The Andrews process of rustproofing may be used in finishing machine parts or those which have been cast, rolled, stamped, etc. It is conducted by supporting the work on racks or some other convenient form of holder that will allow the oxidizing atmosphere of the furnace to come into intimate contact with all surfaces of the work to be rust-

proofed. Care should be taken not to lay the work on a rack or other form of supporting member which has a flat surface of any appreciable size in contact with the work, as such a condition would tend to retard the rustproofing process and prevent the obtaining of a uniform surface. In addition to detracting from the appearance, such a failure to rustproof the entire surface uniformly would also greatly detract from the efficiency of the treatment in preventing the formation of rust.

If moisture or any other corrosive element is able to penetrate beneath the rustproof surface at any point, it will start a formation of rust which will then proceed without restraint. The work to be treated is placed in the furnace and allowed to remain for a period of approximately fifteen minutes, after which it is removed and quenched in oil of a special composition. The work is then removed from the oil and dried in sawdust or by any other means, and finally it is rubbed to remove any slight traces of oil which may still adhere to the work, and to impart the desired degree of luster. Not only does this process afford an opportunity to substitute parts made of inexpensive ferrous metals in place of more expensive brass, copper, or other materials formerly employed, but it is also claimed to be the means of making a substantial improvement in the appearance of the work. The Andrews Rustproofing Laboratories are licensing manufacturers to use this process on a royalty basis.

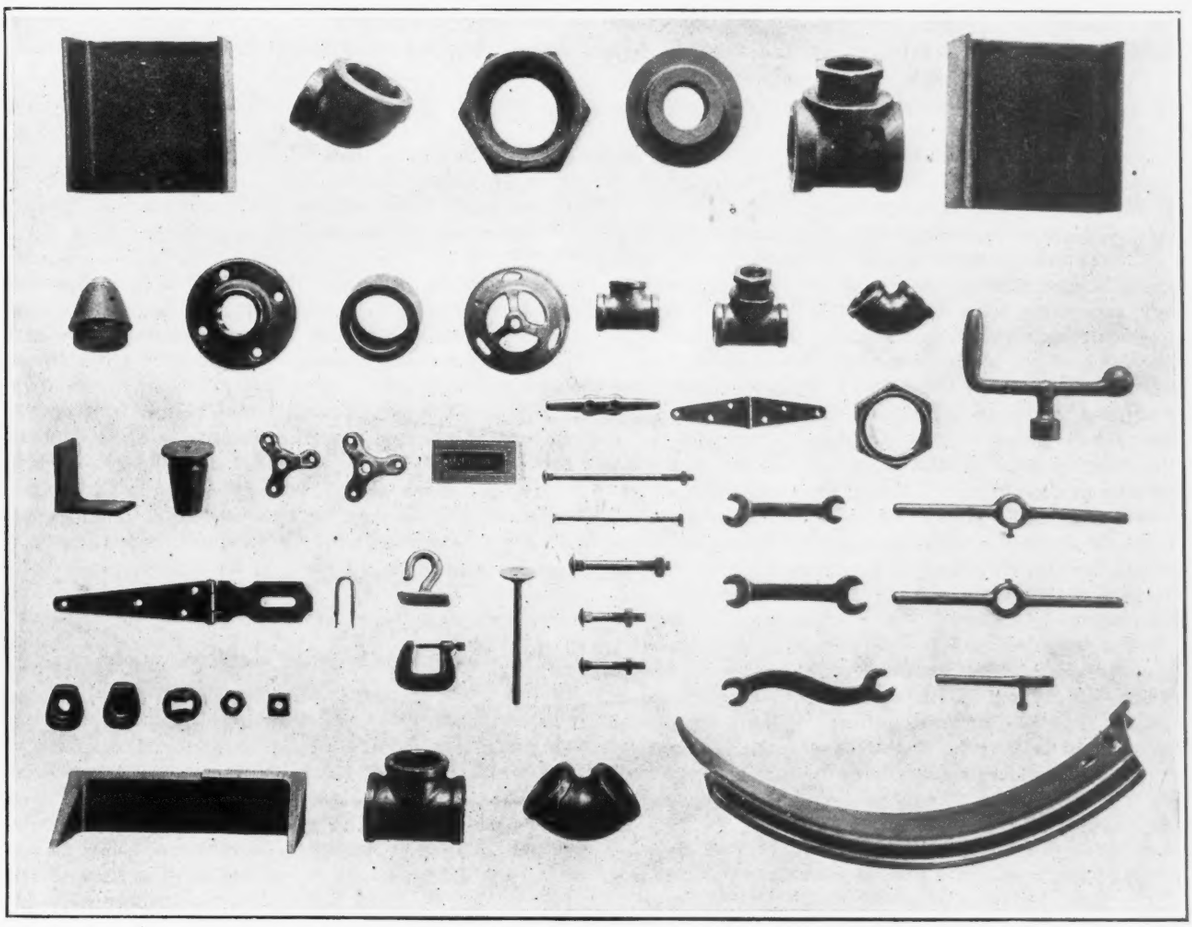


Fig. 2. Examples of Work rustproofed by the Andrews Rustproofing Process

* * *

According to a recent commerce report, the price of French steel cannot be reduced materially for some time owing to the existing wage scales and the present cost of living, both of which are three times what they were before the war, while coal is six to ten times higher than before the war.

ELECTRO-DEPOSITION OF IRON IN REPAIRING MOTOR VEHICLES

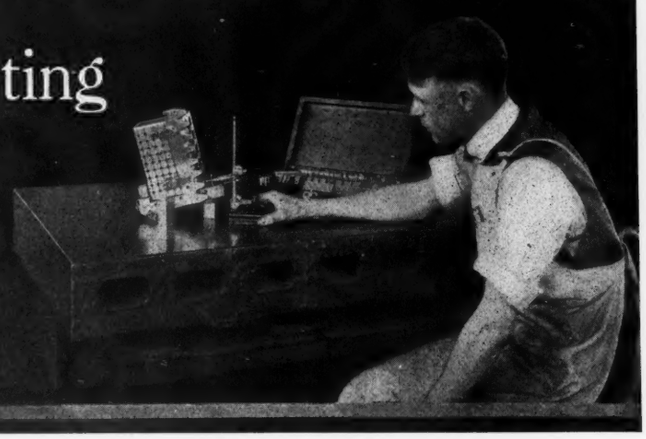
Methods of obtaining the electro-deposition of iron in the repair of motor vehicles were described recently before the Institute of Automobile Engineers by B. H. Thomas who developed the process. It has been found possible to deposit a layer of iron up to about 1/16 inch in thickness on any simple cylindrical surface of wrought iron or steel. This layer adheres firmly to the base metal when the work is properly done, and it is practically impossible to chip it away with hammer and chisel. The surface on which it is deposited does not require preliminary coppering. The layer can be subjected to a red heat without apparent deterioration, can be carburized and hardened, and presents a very smooth surface. This surface can be filed or ground and takes a high polish. The process has proved entirely satisfactory on such parts as brake- and clutch-shaft ends and starting-handle spindles.

* * *

DEMAND FOR STEEL PRODUCTS IN FRANCE

It is reported that steel manufacturers and merchants throughout France believe that the present demand in France for foreign steel products, including plates, sheets, beams, channels, iron rods, tubes, and angles for railroad car construction will continue for at least a year. No home-made plate is available for the independent shipbuilding plants, and such ship plate as is now produced passes directly from the mills to shipyards in which the mills are financially interested. Lack of coal and coke has already reduced the iron and steel production to one-third, but conditions are gradually improving and it is predicted that two-thirds the pre-war capacity will be attained within a year.

Inspection and Testing in Interchangeable Manufacture



Principles Involved in the Inspection of Interchangeable Parts, and Duties of Inspection Department

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

WITH any system of inspection, the tendency of the productive departments is to neglect all thoughts of the ultimate use of the parts in process and to concentrate on efforts to increase production, the standard of quality apparently being anything that the inspector will not reject. Thus, an unfortunate situation almost inevitably arises, the production departments considering only the detailed manufacturing problems and constantly seeking the line of least resistance as regards the machining; while the inspectors either connive at this or arbitrarily insist on the exact letter of the drawings and specifications without regard to the ultimate use of the part in question.

Neither of the above forms of inspection is satisfactory. In previous articles on interchangeable manufacturing published in MACHINERY, it has been pointed out that seldom, if ever, are the drawings and specifications complete or correct enough to be followed blindly. The mere meeting of the drawing requirements is not in itself the prime object of manufacturing. The main purpose in all branches of interchangeable manufacturing is to promote the economical production of satisfactory mechanisms. If the inspection is to accomplish its part in this work discretion should be used, and due consideration should be given to many factors.

Discrepancy between Part and Drawing

When a piece of work is not in accordance with the component drawing, any one of several conditions may be present: First, the part may be wrong and the drawing correct. Second, the part may be correct and the drawing in error. Third, both the part and the drawing may be correct. And fourth, both the part and the drawing may be wrong. In the first case, if the part cannot be salvaged, it must be scrapped. In the second case, the part should be accepted and steps taken immediately to have the drawing corrected. The third case requires more consideration. For almost every problem there is more than one satisfactory solution. If the part as made can be reproduced at a lower cost than one in accordance with the drawing, the part should be accepted and the drawing corrected accordingly. But if the part as made is more difficult to reproduce, the drawing should remain unchanged, although the part need not be rejected. In the fourth case, if the part cannot be salvaged, it is, of course, scrapped; but the necessary corrections should be made on the drawing as soon as possible.

In all of this work, due consideration must be given to the succeeding manufacturing operations and the equipment provided for performing them. When elaborate manufacturing equipment is provided, it is often cheaper to scrap parts that might otherwise be salvaged, because of the difficulty of completing them with the existing equipment. It is obvious that when a great volume of production is involved, discretion can be exercised by but few of the inspection personnel. Hence any abnormal volume of rejections by the inspectors should be the occasion for a re-inspection of the rejected parts by suitable persons competent to locate the error, whether in parts or drawings.

Incomplete Drawings and Specifications

The original drawings seldom give information complete in every detail which is necessary to produce every part. The production departments, however, must complete the parts with or without the assistance of the drawings and specifications, while the inspection department must decide whether or not the parts thus produced are satisfactory. The first solution of some of these indefinite points may not be the best one, and several different methods may be tried out before one that is entirely satisfactory is reached. During all this development, the inspector must give a great deal of consideration to the problem so as not to delay production unnecessarily and still insure a satisfactory product. As soon as any problem is solved, the inspection department should be responsible for passing the information along to the proper persons so that it may be recorded.

The proper inspection of the many parts of an interchangeable product is one of the most important as well as most difficult tasks in manufacturing. On the one hand, if inspection is carried on in an arbitrary and exacting manner, it will retard production and increase the cost of manufacture. On the other hand, if it is done in a perfunctory and lenient manner, it is worse than useless, as it will not prevent the sending out of an unsatisfactory product. The principles of inspection formulated in this article, if correctly applied, will promote the economical production of parts on an interchangeable manufacturing basis and will insure that all requirements are met.

Position of Inspection Department

This makes it clear that the inspection department, among its other duties, must act as eyes for the engineering department. For this reason, in some plants the inspection department reports to, and is virtually a part of, the engineer-

ing department. In other plants, it is a distinct department and is responsible to the management. Either plan usually works out well. In no event should it be a part of, or subordinate to, any production department. The duties of the production and inspection departments are so incompatible that they should never be combined, and if they are, one or the other is bound to suffer. Nevertheless, the inspection should be carried on in close cooperation with the production departments, as well as with all other departments of the organization.

The mechanical inspection of component parts falls logically into two main divisions: The first is the shop inspection which is performed while the parts are in the process of manufacture. The object of this inspection is to cull out defective work as early as possible and to discover any defects in the manufacturing equipment which result in faulty work. The second division is the final examination of the completed parts. The object of this is to see that all components that will function properly are accepted, and all unserviceable parts rejected. There is also the inspection, or testing, of the assembled mechanism to detect faults that have not been detected prior to assembling the parts.

Shop Inspection Methods

When the production is continuous, the shop inspection should be so established that the parts are rigidly inspected after each machining operation on every important functional surface. The requirements of these surfaces should be definitely determined and recorded as early as possible, and these requirements should be rigidly maintained. These inspections are as important as any of the productive operations, and should be maintained accordingly. The inspection of non-functional and other unimportant surfaces can usually be handled by an inspector who passes from department to department and periodically checks a small percentage of the product at each machine. If errors are discovered, the machine should be stopped and the set-up corrected, but the parts at fault should not necessarily be rejected.

The person in charge of inspection has one of the most difficult positions to fill. A great part of his work in promoting economical production is to prevent faulty parts from being made—not only to prevent them from being used. When an operation is first set up, the product should be checked. Even when it is satisfactory, succeeding parts must be watched so that errors may be corrected before any appreciable amount of work is spoiled. To fulfill these duties properly without antagonizing those engaged in production, is a task requiring tact and diplomacy. An arbitrary inspector would stop production entirely; while on the other hand, an inefficient inspector can soon ruin the reputation of the firm. A grave mistake on the inspector's part in either direction will cause much needless expense.

The inspectors are, of course, supplied with the necessary gages, limit gages being essential for most of the important functional surfaces, while "Go" gages alone are usually sufficient for surfaces of lesser importance. Definite lists of the essential inspections or important functional surfaces should form a part of the specifications. These may be combined with the operation lists or may be made up as separate schedules. Whether or not each individual piece of work should be inspected depends largely on the character of the operation. On many automatic operations, a percentage inspection is sufficient; while on most hand operations, where each piece is handled individually and the personal skill of the operator is a factor, a one hundred per cent inspection is usually required.

The inspection of screw machine parts made from bar stock is a case where the inspection of a minor percentage is sufficient. The practice in one plant is as follows: Each automatic screw machine has, as part of its equipment, several small metal work boxes or baskets which are numbered consecutively. These are used in order, and about every fifteen minutes the one on the machine is removed and placed on a bench, while the one with the next number is placed on the machine. An inspector makes periodical visits and inspects a few parts from each basket. If these are satisfactory, all the parts are removed and the empty basket is returned to the machine operator. If a faulty piece is found in any basket, the entire contents of that basket, all succeeding ones, and also the one preceding it, are set aside for a one hundred per cent inspection while the machine is stopped immediately and its set-up corrected.

This general plan is adaptable to many other operations, such as sub-press die work and other punch press operations, for example, where the set-up and condition of the tools alone practically control the uniformity of the product. The shop inspection should be carried on as soon after the machining operations as possible. In the case of very large parts, the piece is often inspected before it is taken from the machine, which saves a new set-up if corrections are necessary.

Personnel of Shop Inspection

Much of the detail work of testing the parts with gages, particularly on small work, requires little mechanical knowledge or skill, and is often satisfactorily performed by girls. When the quantity of production is large, and the inspections are subdivided into elementary tasks, a relatively small amount of training will develop efficient detail inspectors. The supervisor of such work, however, should be not only a good mechanic, but also a person well acquainted with the requirements of the product. The successful chief inspector must be firm but diplomatic; his duties must never degenerate into fault-finding.

The person in charge of the shop inspection has one of the most difficult positions to fill. A great part of his work in promoting economical production is to prevent faulty parts from being made. When an operation is first set up, the product should be checked. If it is satisfactory, the succeeding parts must be watched so that the set-up may be corrected before any work is spoiled. If the first parts do not meet the requirements, the set-up must be corrected before production in quantity is started. To fulfill these duties properly, without antagonizing those engaged in production, is a delicate task and the closest cooperation is necessary. An arbitrary inspector will soon stop production entirely. On the other hand, an inefficient inspector can soon ruin the reputation of the firm. A grave mistake on the inspector's part in either direction will inevitably cause much needless expense.

Final Inspection of Work

In many ways the function of the final inspection is quite different from that of the shop inspection. The latter deals with the parts as they are being shaped from the raw material. Nothing should be left undone to promote their completion in accordance with the drawings and specifications. The final inspection, on the other hand, deals with the parts after all the machining operations have been completed. Its main function is to see that all parts which will give satisfactory service are accepted, and that those which will not are scrapped. This result alone should be striven for, regardless of technical violations of the drawings and specifications. Under normal conditions, such violations should be rare. If conditions are abnormal, steps should be taken to correct them, but such steps should never involve the rejection of serviceable parts.

In general, gages used in the final inspection should be functional gages only. If the detailed shop inspection is

properly organized, there is no need to duplicate it here. If it is not functioning properly, the trouble should be corrected at its source. Both the shop inspection and the final inspection should be under the general direction of the same person. All final decisions as to the acceptance of questionable material, whether questioned by the shop inspection or the final inspection, should also be made by the same person.

One of the duties of the inspectors who perform the final inspection should be to watch the work of assembly, in addition to testing the assembled product. If the component parts assemble properly, and the completed mechanisms function as they should, no further evidence is needed that the productive work has been properly done. If the parts give trouble in assembling, or the mechanism fails to function, immediate steps should be taken to locate the trouble and correct it at its source. Thus the assembling departments form the best points of vantage to watch and judge the results that are being obtained.

Inspection of Gages and Material

The inspection of the gages used in the course of manufacture is one of the vital functions of the inspection department. As gages become worn, they permit parts larger or smaller, as the case may be, to pass inspection. The adjustment of a machine or tool is not changed as long as the parts produced satisfy the gages used in their inspection, and so all gages should be checked periodically and corrected or replaced as found necessary. Too often this is not done until trouble has developed. One of the principal objects of inspection is not to locate the cause of trouble after it has happened, but to forestall and prevent it. A systematic inspection of gages is one of the surest means of accomplishing this end.

One of the duties of the inspector who performs the final inspection should be to watch the work of assembling, in addition to testing the assembled product. If the parts can be assembled easily and the completed mechanism functions properly, it is the best possible evidence that the work of the production department has been properly done. If the parts give trouble in assembling or the mechanism fails to function, immediate steps should be taken to locate the trouble and correct it. Thus the assembling department forms the best point of observation for judging the results obtained by the productive organization.

Most of the inspection of the composition and physical strength of materials belongs in the chemical and metallurgical laboratories. When a part is subjected to unusual stress, it is customary to make a chemical analysis of each bar of stock as it is received. This, and other specified physical tests are seldom considered in connection with the mechanical inspection of the product. Often, however, after such operations as forging, hardness tests are made in conjunction with the other inspections to insure that the metal is in proper condition to be readily machined. Such tests are usually made with simple testing instruments, such as a Brinell testing machine or a scleroscope, the mechanical operation of which requires no more skill than the proper handling of gages, and are, therefore, usually conducted by the regular mechanical inspection personnel.

Testing of Assembled Mechanisms

Whenever possible, the assembled mechanism is tested by actually having it perform the work it is intended for. Thus, a newly completed automobile is usually sent out for a road test before being shipped; a typewriter is manipulated by an operator; a rifle is tried out by a marksman, etc. These tests, of course, only prove the condition of the mechanism while new. The test of service depends upon the materials used in its construction and the honest workmanship which has been built into it at every stage beginning with the designing and followed by the careful and watchful work of the productive operators, the vigilance and good judgment of the inspectors, and the care and attention of the assemblers. No one factor is predominant. All are essential and each one must be carefully studied in order to develop and maintain a smooth flow of production.

DRILL JIG FOR CREAM SEPARATOR FRAMES

The machining of the cast-iron frames of cream separators involves some interesting drilling work on account of the many holes which they contain, some of which are not readily accessible. The interior of the casting contains many cored pockets of irregular shape into which holes are drilled at various angles. It is imperative that these holes be accurately located with respect to each other, and it is equally imperative, for this reason as well as for economy in machining, that they be machined without relocating the castings any more than is absolutely necessary. A jig for this work was designed by the engineers of the De Laval Separator Co., Poughkeepsie, N. Y., by means of which these operations can be performed accurately and with a minimum amount of handling. This jig and the Cincinnati-Bickford radial drilling machine on which the work is performed are shown in various positions in the accompanying illustrations, together with the set-up for drilling some of the holes in the casting.

The jig, as will be apparent by referring to the illustrations, is a heavy cast-iron frame which is supported by trunnions that have bearings in, and are supported by, two substantially ribbed standards. By supporting the frame in this manner, provision is made for tilting the work to any desired angle from the horizontal when locating the frames during the drilling operations. The work is held on pilots which fit previously bored holes in the top and bottom of the frames, so that all holes machined in this jig are located from the center line of the castings. These pilots are clearly shown in the illustrations, and it will be seen that the one which engages the hole in the bottom of the casting, shown at *A*, Figs. 1 and 2, contains a rack with which a gear meshes to advance the pilot into the hole when locating the casting in the jig. The handle *B* employed to revolve this gear also operates a locking device which prevents the work from moving from its points of support.

An upright arm *C*, containing a number of bushed holes, enables the jig to be set at various angles from the horizontal, and a plug *D*, Fig. 1, is employed to lock the jig in the position desired for any particular operation. The three views of the jig illustrated show this heavy yoke frame in three different positions, the one in Fig. 2 being the extreme angle above the horizontal, for the location of which, the use of an extension arm is required. When the maximum angle below the horizontal is required, use is made of the lowest hole in the upright arm, in which position the work is about 15 degrees from the vertical. During these various operations, the work may also be rotated on its axis to permit the holes to be machined at any desired angle. The head *E* of the jig, Figs. 1 and 3, has a number of bushed holes in it and a lock-pin *F*, Fig. 3. This illustration shows a good view of the head of the fixture. It will be apparent that a jig of this construction is universal in adjustment, in the sense that any angle including the vertical, can be obtained by making suitable allowances in the design.

Fifty-two operations are performed on the frames, and an idea of some of the tools used in these operations may be gained by observing the contents of the tool-board and worktable, Fig. 2. There are twenty-eight drilled holes, nineteen of which are tapped, four of which are faced, and one countersunk. Four auxiliary fixtures are used, so designed as to fit and fasten readily to previously planed surfaces on the

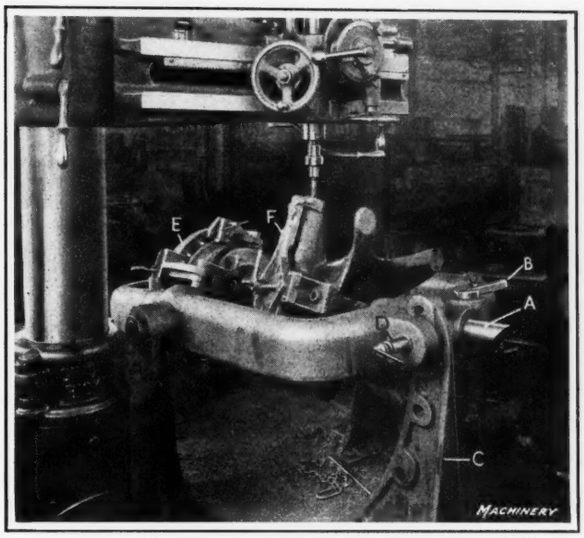


Fig. 1. Yoke Type of Jig for supporting Cast-iron Frames when machining on a Radial Drilling Machine

casting. One of these attached fixtures is shown in position at *F*, Fig. 1. It is unnecessary to enumerate each operation performed on this cream separator frame; however, mention will be made of one operation in which a hole is drilled through the bosses *G* and *H*, Fig. 2, and the ends of the bosses are faced to an accurate over-all length.

The hole is first drilled through one of the bosses, passing through the cored chamber of the casting, and is then faced with an ordinary pilot counterbore. A gage *J* is then dropped into this hole, in which it is supported by means of a drift-key driven into the key-slot in the gage. There is an opening on the side of the casting which permits the drift-key to rest on the wall of the casting, so that when driven in, its taper will wedge against the wall and hold the gage in the hole as a stop for the counterbore pilot of the tool used in facing the boss on the opposite side to the desired over-all length. It will be seen that "Presto" quick-acting collet chucks and collets are used, and also that a number of extension drills and taps are employed. The production time for the drilling operations in this jig is one hour and thirty-five minutes, floor to floor.

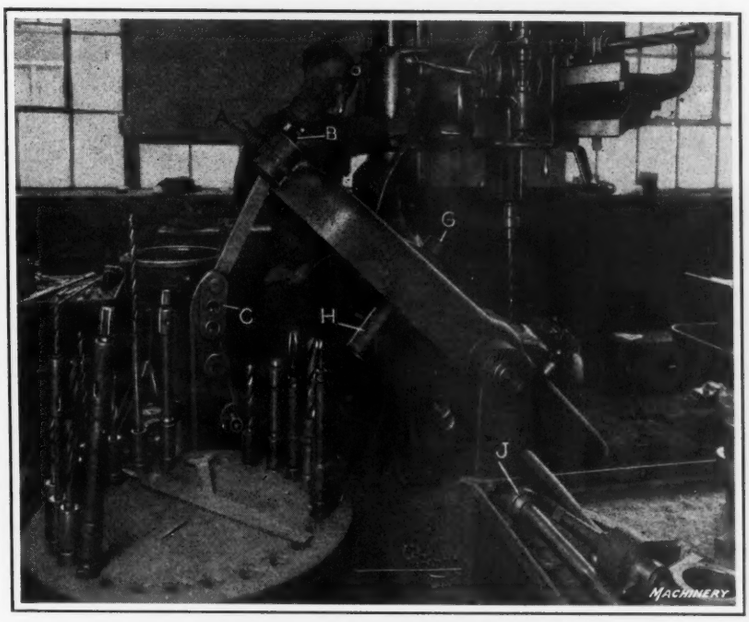


Fig. 2. Another View of the Trunnion-supported Jig in Elevated Position

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The Westinghouse Research Laboratory conducted experiments to determine what treatment would make iron-nickel alloys more readily forgeable at ordinary forging temperatures. Aluminum, chromium, magnesium, and silicon have been found to have hardly any effect, but 2 per cent of either manganese or titanium imparts the desired characteristics and makes the alloys forgeable. The theory is that these elements have the ability to so strengthen the uncrystallized material that it possesses greater strength than the crystals.

RAPID CONSUMPTION OF OIL SUPPLY

A paper was presented before the American Iron and Steel Institute by George Otis Smith, director of the United States Geological Survey, in regard to the rapidly diminishing oil resources of the United States. Ten years ago the wells were adding 15,000,000 barrels per year to our reserve stocks, while in the last nine months the stored petroleum has been drawn upon to the extent of 15,000,000 barrels. The first three months of 1920 have established a rate of domestic production that will mean a total of 415,000,000 barrels for the year, while the consumption will be about 490,000,000 barrels. The estimated quantity of petroleum remaining available in the ground in the United States is 7,000,000,000 barrels; thus, if the present rate of consumption of almost half a billion barrels per year continues, the estimated supply will only last about fifteen years longer.

* * *

SAWING METAL BY HAND

Experiments have been undertaken in France to determine the best method of sawing metal by hand. These experiments indicate that it takes less time to saw off a rectangular bar of steel when the saw is moved parallel to the shorter side of the rectangle than when it moves parallel to the longer side. It was also found that the shorter the stroke of the saw, the quicker would the bar be sawed off. In sawing off a rail by a hacksaw, it required nearly three times as long when the stroke was 4 inches in length as compared with when it was somewhat less than ½ inch in length. The work performed per minute decreases regularly for each half inch increase in the length of the stroke. It is also stated that by holding down the end of the saw farthest away from the workman—not by hand but by a weight—the time required for sawing through a bar is shortened, a thinner blade can be used, and a better surface on the ends of the sawed off bar is obtained.

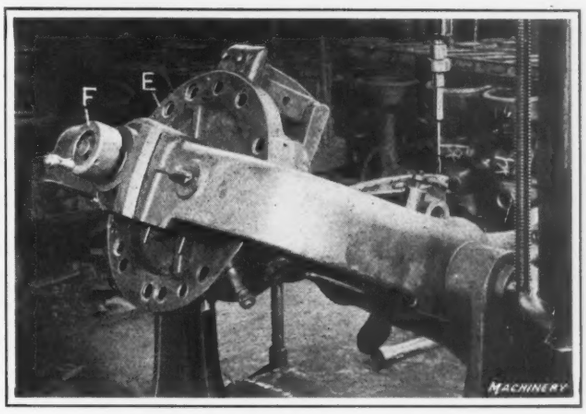


Fig. 3. View showing the Head End of the Jig and a Third Position in which the Work is held

Preventing Distortion in Hardening Tools

IT is a matter of general knowledge that during the process of heat-treatment to which metal-cutting tools are subjected to give them the requisite degree of hardness, there is a tendency for the steel to be distorted. This may not be a serious matter in many cases, because, after heat-treating, the tool is subjected to a grinding process which brings it back within the required limits of accuracy. However, in the case of such tools as slitting saws, broaches, etc., the distortion may prove serious unless special precautions are taken for its prevention. In the following article a description will be given of some fixtures which have been developed by the Illinois Tool Works, Chicago, Ill., which afford means of overcoming difficulty of the kind just mentioned.

With two of these fixtures, the practice is to remove the heated tool from the furnace and clamp it in place before quenching, so that there will be practically no opportunity for the metal to spring out of its proper form. In the case of the third fixture, for use in hardening broaches and similar shaped tools, which are of very great length in comparison with their diameter, the method of procedure is quite different from that just mentioned. At the time that it is immersed in the quenching bath, the tool is being rotated at high speed. This thoroughly agitates the bath and assures a uniform cooling action on the tool. Consequently, there is very little chance of developing unequal strains in the steel and the resultant distortion that is produced by such a condition. The following description and illustrations fully explain the features of these three equipments which are used for the elimination of distortion in heat-treating tools.

Method of Hardening Circular Saws

For use in hardening circular saws and other work of the same general form, successful results are obtained through the use of a machine illustrated in Fig. 1. Briefly stated, this method consists of securely clamping the work between pointed steel pins which are able to hold the saw securely enough to prevent distortion but, owing to the extremely small areas in contact with the heated work, these pins do not tend to withdraw heat rapidly. After the work has been clamped in this way, it is submerged in the quenching bath, and as the work is rigidly held, it will not be warped out of shape during the process of hardening. Having made this preliminary statement, the following description will be readily understood. Mounted on the quenching bath *A* there are two bearings *B* and *C* which support a horizontal shaft *D*. Secured to this shaft there is an arm *E* that has a horizontal arbor *F* and a disk *G* mounted at its upper end, and distributed over the inner face of the disk there are concentric rings of pointed pins, the circular rows of pins being distributed at intervals of ½ inch from the center of the disk.

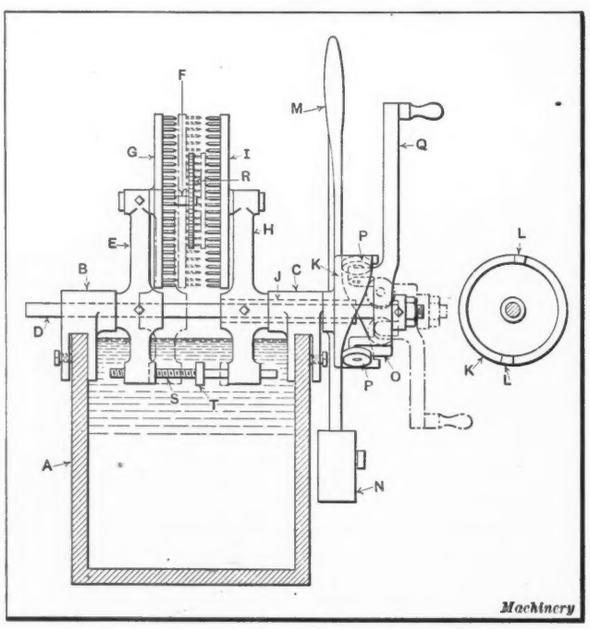


Fig. 1. Fixture for clamping Circular Saws and Similar Tools preparatory to quenching

It will be seen that there is a second arm *H* and disk *I* which are of essentially the same form as *E* and *G*, respectively; but arm *H* is secured to a sleeve *J* and abuts against the left-hand end of bearing *C*. Secured to the right-hand end of sleeve *J* there is a double-tracked cam *K* which abuts against the right-hand end of bearing *C*. The best idea of the arrangement of the two tracks on cam *K* will be gathered from the detailed end view, where it will be seen that the two tracks are divided by stops *L*. Immediately before reaching the stop *L* each cam track has attained its maximum rise and assumed a horizontal position. Secured to cam *K* there is a handle *M* which projects beyond the cam to support a counterweight *N*, the mass of which may be varied according to the size of disks *G* and *I* and of the work to be placed between these disks.

Secured to the extreme right-hand end of shaft *D* there is a yoke *O* on which two rollers *P* are mounted to run in contact with the two tracks on cam *K*. Yoke *O* is extended at one end to form a crank handle *Q*, which provides for turning the yoke through half a revolution so that the rollers *P* may run over the cam track until they come into engagement with stops *L*. In riding up the incline of the cam tracks, these rollers force yoke *O* to the right, and through positive engagement through shaft *D* and arm *E* the arbor *F* and disk *G* are also moved toward the right. The work to be hardened is shown at *R*, and as disk *I* occupies a fixed longitudinal position, it will be evident that the movement of disk *G* results in clamping the work between the two sets of pointed pins, as indicated by the dotted lines which show disk *G* in its right-hand position.

While turning handle *Q*, handle *M* is held in a stationary position to prevent sleeve *J* from turning and, as previously mentioned, when the rollers *P* come into engagement with stops *L*, they have run on the two horizontal portions of the cam tracks so that the mechanism is locked. After this has been done, lever *M* is turned through a half revolution, which causes the two disks *I* and *G* to swing downward and submerge the work in the fluid contained in quenching bath *A*. It will be evident that lever *M* is directly connected to arm *H* through sleeve *J*, and connection between arms *H* and *E* is accomplished by extending the lower ends of these arms and having a rod *S* threaded at one end to enter a tapped hole in arm *E*, while the smooth end of rod *S* slides in a reamed hole in arm *H*. An adjustable stop *T* is provided, which is set on rod *S* according to the thickness of the work *R*, so that this stop abuts against the lower end of arm *H* when the pins on disk *G* have clamped the work firmly aginst the pins mounted on disk *I*. It will be evident that when arm *M* is turned through a half revolution to submerge the work in the quenching bath, arm *Q*, which is secured to the end of shaft *D*, also turns through another half revolution. As previously stated, an arrangement of this kind

rigidly clamps the work in a perfectly flat position, making distortion practically impossible.

Hardening Circular Saws between Metal Plates

Fig. 2 illustrates another method of hardening circular saws which has given very satisfactory results. In this illustration, the saw is shown at *A* where it will be seen that it rests upon pointed pins *B* which are arranged in concentric circles at intervals of ½ inch to provide for holding saws of various sizes. However, attention is called to the fact that in this case, the pins are merely utilized to support the work preparatory to clamping, and they do not exert any permanent clamping effect. Referring to the detailed illustration of a pin shown at the left-hand side of the illustration, it will be apparent that each pin *B* is supported

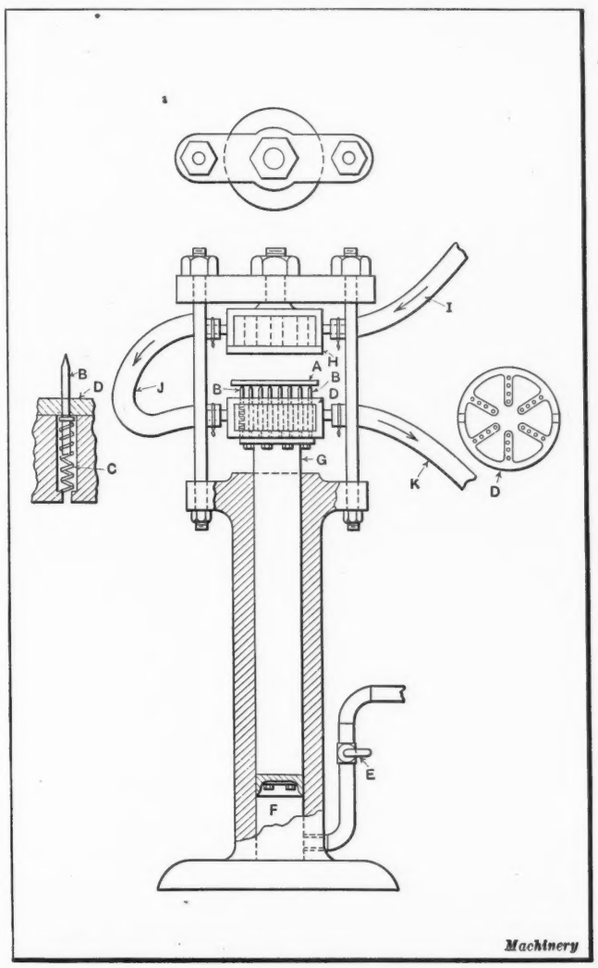


Fig. 2. Method of quenching Circular Saws between Water-cooled Copper Plates to prevent Distortion

by a compression spring *C* so that the pin may be pushed back level with the face of plate *D*. After a saw has been raised to the proper quenching temperature, it is removed from the furnace and laid on pins *B*, after which valve *E* is opened to admit air to a cylinder *F*. This causes rod *G* to rise and carry up with it the box of which plate *D* forms the upper part. If the saw were placed on plate *D* instead of on the pins *B*, one side of the saw would be cooled before the other, and cause the tool to be warped.

When saw *A* comes into contact with plate *H*, further movement of rod *G* causes pins *B* to recede against the tension of springs *C*, this movement continuing until the saw is rigidly clamped between plates *D* and *H*. These plates are preferably made of copper, which is one of the best known conductors of heat; but brass, bronze, or some similar metal may be satisfactorily used as a substitute. The rapidity with which the work is quenched is further facilitated by maintaining a constant flow of water through the boxes of which plates *D* and *H* form parts. Water enters the upper box through tube *I* and thence passes through tube *J* to the lower box, finally emerging through tube *K*, the direction in which the water flows being indicated by arrows. The compressed air cylinder *F* applies sufficient pressure to hold the work tightly between plates *D* and *H* and thus prevent any danger of distortion. Valve *E* is so arranged that when turned into the position that shuts off the air, this valve also allows the air contained in cylinder *F* to be exhausted.

Fixture for Preventing Distortion of Long Slender Work while Hardening

In hardening long slender tools such as drills, reamers, taps, or broaches, the prevention of distortion is successfully

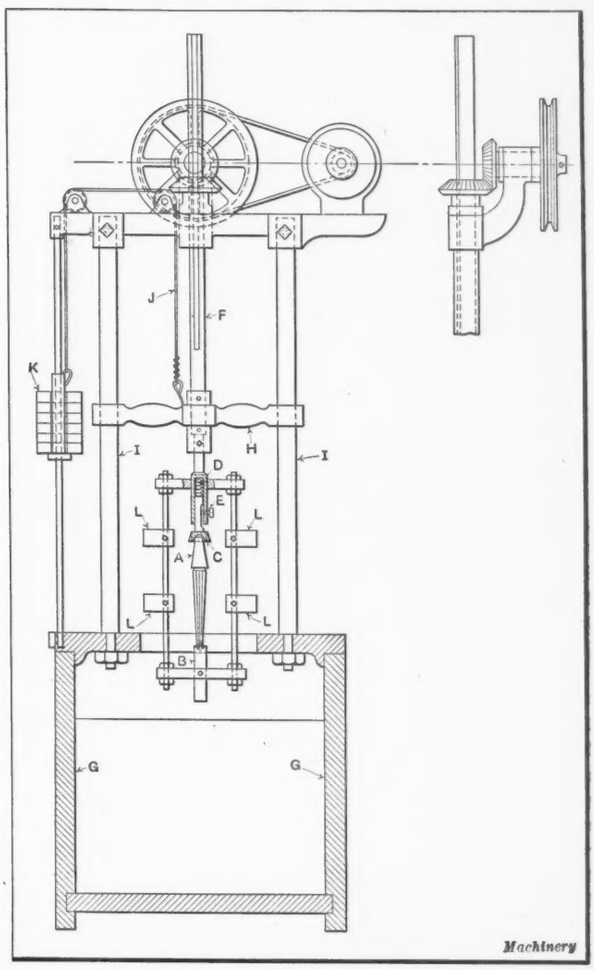


Fig. 3. Method of rotating Broaches and Similar Shaped Tools to prevent Distortion while quenching

accomplished through the use of a fixture of the form shown in Fig. 3. Such an apparatus could also be employed with satisfactory results for handling the heat-treatment of many types of shafts, among which those used in the construction of motor cars are a typical example. After the work has been raised to the proper hardening temperature, it is subjected to a spinning action while quenching, the work being submerged in the bath in a vertical position while being rotated at high speed by the machine. A reamer *A* is shown, but the method of supporting the work would be similar in all cases. Two cup-centers *B* and *C* support the tool to be hardened, the lower center *B* being fixed, while the upper center is free to slide back in its socket against the force exerted by a compression spring *D*. A set-screw *E* projects through the wall of the socket and enters a slot in the shank of cup-center *C* to prevent it from falling out of the socket when the work is removed. Power for rotating the work is

provided by an electric motor, which transmits motion to the vertical shaft *F* by means of a belt and bevel gears; and it will be seen that the shaft is splined into the driving gear to allow for imparting the necessary vertical movement.

To provide for submerging the work *A* into the quenching bath, which is located at the bottom of the machine and indicated at *G*, the operator grips handle *H* which is provided with a bearing in which the driving shaft *F* is free to rotate; handle *H* also embraces the two guide rods *I*, and is free to slide on them. Connected to the handle there is a cable *J* that runs over pulleys to a counterweight *K*, which is made of the independent disk type, so that it may be adjusted to counterbalance the weight of the work that is being handled in the machine. It will be apparent that the two work-holding centers *B* and *C* are connected by a yoke consisting of two vertical and two horizontal rods. This yoke rotates with the work, and secured to the vertical members of the yoke there are four agitators *L*, which thoroughly stir up the quenching fluid, so that its temperature is maintained uniform instead of becoming locally heated near the hot piece of work; also, this agitation prevents danger of the formation of steam pockets near the work, which would retard the process of hardening. With an equipment of this kind, uniform hardness and freedom from distortion are secured through the possibility of having heat withdrawn at the same rate from all surfaces of the work, thus preventing the development of uneven strains.

* * *

MOLDING AN ANNEALING BARREL

By M. E. DUGGAN

The following deals with a molding proposition in which the production of a casting for the rotary annealing barrel shown in Fig. 1 is involved. The casting contains no openings at either end, but has an opening, 5 by 24 inches, at the side, for charging the barrel. As first planned, the pattern was made split through the center, to be molded on its side. For the production of the body core a skeleton core-box was furnished. This method of molding was deemed inefficient by the foreman of the foundry, with the result that the problem was handled in a radically different way.

The pattern was made solid so as to mold it on end, and the skeleton core-box was changed to a regular half core-box. The assembled core weighed 575 pounds, and in molding, the pattern had to be supported on four chaplets, which are shown in Fig. 2, resting on the slab cores *F*. These cores were rammed in the bottom of the mold directly under and next to the pattern. The thickness of the walls of the barrel was ¾ inch, so that by using three wooden strips of this thickness, the core was centered in the mold. The core was held down and secured at the top by means of the four chaplets *G*, which press down on the core, their stems passing up through the cope and against a wooden cross-bar secured to the cope flask. An air vent was made consisting of two vertical channels *B*, which were connected by a cross-channel *C* located near the top of the core. This cross-channel continued on out through the core *E*, thence into the molding sand and up to the top of the mold. The slab core *E*, provided for the charging door in the side of the casting,

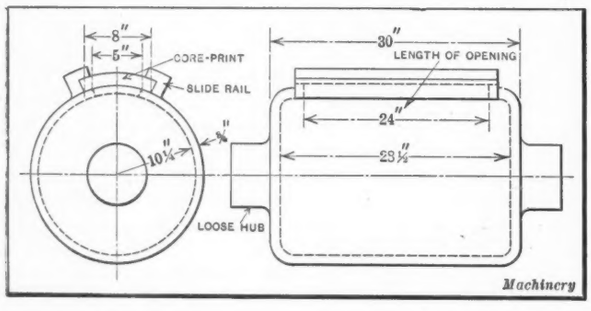


Fig. 1. Pattern of Rotary Annealing Barrel which was molded on End

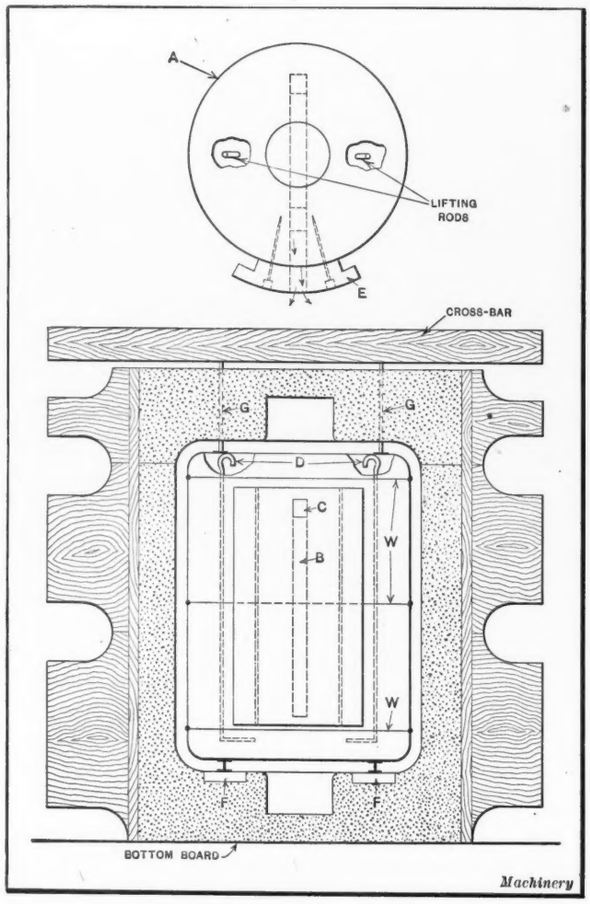


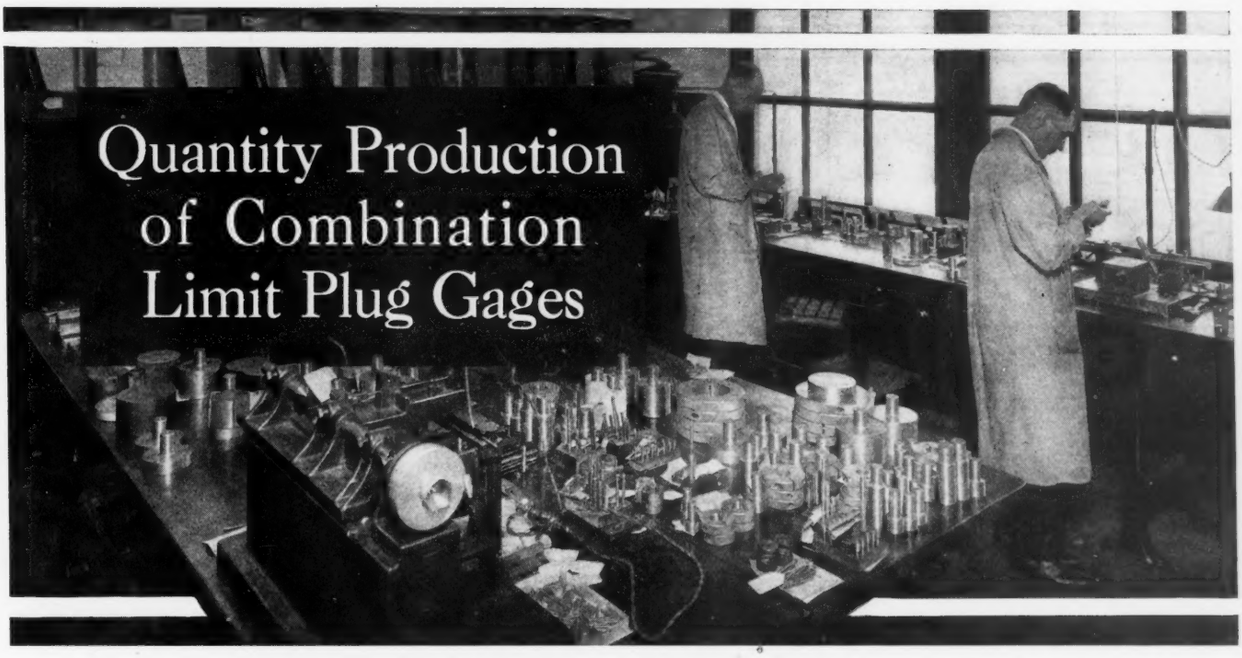
Fig. 2. Section of Mold and Arrangement of Core used in producing the Annealing Barrel shown in Fig. 1

was fastened to the body core *A* by five 20-penny nails. In using nails to hold this core to the body core, it was necessary to drill holes in the cores. Five holes were drilled with a piece of core wire through the slab core, these holes being used to locate those in the body core. The slab core was then pasted in position and nailed securely in place. The two half cores, after being pasted together, were reinforced by three binding wires *W*. Two lifting rods *D* were provided in the heavy core for lifting it from the mold.

The advantage gained by molding this pattern by the method just described is that only two and one-half hours is required to make the core with the half core-box, whereas four hours was required when using the skeleton core-box. In addition to this, the core made from a skeleton box is not as satisfactory as when made in a regular half core-box.

* * *

In a paper recently read before the American Society of Mechanical Engineers, it is stated that the principal aluminum alloy used for castings in the United States consists of about 92 per cent aluminum and 8 per cent copper. This composition is generally known as the No. 12 alloy of the Aluminum Co. of America, or as the Society of Automotive Engineers' specification No. 30. When a ½-inch testing bar is cast in green sand from this alloy and tested without machining off the skin, an average tensile strength of approximately 20,000 pounds per square inch and an average elongation of about 1.5 per cent in two inches will be obtained. A modification of this alloy having somewhat better physical properties is now being used to some extent in the production of castings for the automotive industry. This alloy has an analysis of 7.5 per cent copper, 1.5 per cent zinc, 1.2 per cent iron, and the remainder aluminum. The tensile strength averages about 21,000 pounds per square inch, and the elongation is somewhat greater than that of the No. 12 alloy.



Quantity Production of Combination Limit Plug Gages

Description of a New System of Limit Plug Gages Developed by the Taft-Peirce Mfg. Co., and the Methods Employed in their Manufacture on a Quantity Production Plan

THERE have been several different periods in the evolution of machine and tool equipment for metal manufacturing plants, each of which is marked by the development of some special kind of machine tool or accessory. While at all times since America became the leader in the machine tool building industry of the world, there has been simultaneous progress along all lines of machine tools, gages, and equipment, there nevertheless was a certain period when, for example, the milling machine received more attention and was more rapidly developed than other lines of machine tools. Later, the grinding machine entered into a similar era of development. During the last five years, stimulated mainly by the requirements of the war industries, the development of gages and gaging systems has occupied the most prominent place in the evolution of machine shop methods; and it is safe to say that compared with five years ago, no one large branch of metal-working equipment has developed to the same extent as gage making.

One of the new developments along the lines of gage making that deserves to be recorded is the combination limit plug gage introduced by the Taft-Peirce Mfg. Co., Woonsocket, R. I.—a gage that for want of a better name might be termed an "interchangeable" plug gage, the word "interchangeable" in this case being used, not in the same sense as in the term "interchangeable manufacturing," but rather in the sense in which it is used in the expression "interchangeable counterbore."

Principles of Design of the Combination Limit Plug Gage

Fig. 1 shows at *A* the design of the combination limit plug gage. As indicated, a double-ended limit plug gage made to this system consists of five parts: (1) a gage handle; (2) a "Go" plug gage unit; (3) a "Not Go" plug gage unit; (4) and (5) screws for holding the gage units to the handle.

At *B* in the same illustration is shown a single-ended plug gage made along the same lines, and at *C* a single-ended limit gage having both the "Go" and the "Not Go" limits incorporated in the same gage unit. These are merely variations in design, the standard type being illustrated at *A*, and it is this type that will be particularly dealt with in the following description. It is evident, however, that the gage units employed in connection with gage *A* are also equally applicable to gage *B*, the gage units being interchangeable with any type of handle.

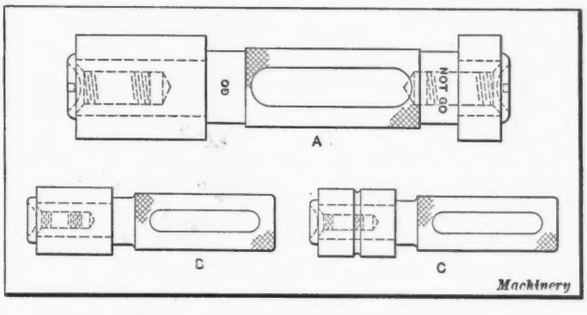


Fig. 1. Design of Gages having Interchangeable Gaging Units

Object of Design Illustrated

At first sight it might be thought that the object of the gage designs shown in Fig. 1 is merely to permit the handle to be made of a cheaper material while the gage units are made from a higher grade of steel. While this is an object that would not be overlooked in economical manufacturing practice, it is not the principal aim sought by the manufacturers in the design of this type, because the principle of the gage involves far more interesting features than the mere assembling of gage units with a handle. The chief idea, and the one that will particularly appeal to users of these gages, is the advantage obtained by the possibility of interchanging the gage units according to the actual limits required in any one case, it being possible for the Taft-Peirce Mfg. Co. to keep in stock a sufficient number of sizes of gage units that can be assembled into limit gages for different tolerances to meet practically every ordinary manufacturing condition. With this in view, gage units for both the "Go" and the "Not Go" ends are made for every 1/16 inch from ½ inch to 3 inches, with three different limit sizes on the units below 1 inch, and five limit sizes on the units over 1 inch. Furthermore, the construction permits easy replacement of gage units, and they may be reversed on the handle when one end is worn, thereby insuring double life to the gage.

The preceding statement will require more detailed information. For example, the "Go" gage units for a 1-inch limit gage will be made with five different diameters —1.000, 0.9995, 0.999, 0.9985,

TABLE OF GAGE COMBINATIONS

Maximum Size, Inches	Minimum Size, Inches	Tolerance, Inch	Maximum Size, Inches	Minimum Size, Inches	Tolerance, Inch
1.500	1.4995	0.0005	1.501	1.4985	0.0025
1.500	1.499	0.001	1.501	1.498	0.003
1.500	1.4985	0.0015	1.5015	1.500	0.0015
1.500	1.498	0.002	1.5015	1.4995	0.002
1.5005	1.500	0.0005	1.5015	1.499	0.0025
1.5005	1.4995	0.001	1.5015	1.4985	0.003
1.5005	1.499	0.0015	1.5015	1.498	0.0035
1.5005	1.4985	0.002	1.502	1.500	0.002
1.5005	1.498	0.0025	1.502	1.4995	0.0025
1.501	1.500	0.001	1.502	1.499	0.003
1.501	1.4995	0.0015	1.502	1.4985	0.0035
1.501	1.499	0.002	1.502	1.498	0.004

Machinery

and 0.998 inch, respectively. The "Not Go" gage unit will also be made with five different diameters—1.000, 1.0005, 1.001, 1.0015, and 1.002 inches, respectively. In other words, all gages over 1 inch are made for the "Go" gage to standard size and with four limits, namely, 0.0005, 0.001, 0.0015, and 0.002 inch smaller than standard size; and the "Not Go" gage units will be made to standard size and the same amounts larger than standard size, as specified. In the case of gages between ½ inch and 15/16 inch inclusive, the "Go" gages are made to standard size and to 0.0005 and 0.001 inch less than standard size, while the "Not Go" gages are made to standard size and to the same limits larger than standard size.

Advantages Gained by Making Unit Gages to Sizes Indicated

It is apparent that with unit gage ends made to the sizes specified and kept in stock, it is possible to assemble at a moment's notice a plug gage for practically any ordinary tolerance used in interchangeable manufacturing work. With three "Go" plugs and three "Not Go" plugs it is possible to obtain eight practicable gage combinations. With five "Go" plugs and five "Not Go" plugs it is possible to obtain twenty-four practicable gage combinations according to the limits and tolerances required for any particular line of work. It is evident that it would not be practicable to keep in stock twenty-four kinds of solid gages, as some of these combinations might seldom or never be called for; but by keeping the gage ends in stock and assembling them according to the customer's requirements, it is feasible to keep a sufficient stock to meet all ordinary requirements. In addition, heat-treated and rough-ground gage blanks are kept in stock for intermediate sizes, which can easily be ground and lapped down to the required diameter for special gage requirements. In order to show the combinations that can be obtained with a 1½-inch limit gage set such as described, the accompanying table has been prepared.

The Manufacture of Combination Limit Plug Gages

The material from which the gage units are made is a high-carbon alloy crucible steel containing chromium and vanadium with a low phosphorus and sulphur content. The chromium in the steel increases its wearing qualities and also aids in resisting corrosion. The vanadium also has a decided influence upon the wearing qualities. The combination of chromium and vanadium in the proportions used produces the greatest hardness and wearing qualities possible in conjunction with a properly workable steel, making it exceptionally well suited for use as a material for plug gages. The handles are made from cold-rolled mild steel. All the work on the handles is plain automatic screw machine work, and after having been completed they are merely blackened for finish and then left soft so that the customer may mark them with his designation of the job to which they belong.

In the manufacture of the gage units the Taft-Peirce Mfg. Co. employs standard manufacturing processes throughout, and the making of gages to a guaranteed accuracy of 0.0001 inch is reduced from a tool-room proposition to a quantity manufacturing production plan. The operations required in the manufacture of these gages are briefly as follows:

The gage blanks are first turned and cut off from bar stock in the automatic screw machine department, at which time the hole through the blank is also drilled and reamed and the blanks are cut off 1/16 inch longer than the finished size. In turning the blanks for the gage units, from 0.010 to 0.015 inch over the finished size is left for grinding. After passing from the screw machines, the ends of the blanks are faced off square with the hole by a straddle tool to the correct finished length, this work being done on a Porter-Cable lathe.

In order to prevent the gage unit from revolving upon the handle, a half round keyway is provided in the gage unit corresponding to a similar keyway in the handle, a pin key being used. This keyway is broached, after which one end of the gage is stamped with the Taft-Peirce trademark under a drop press. From this operation the gage blanks pass to the inspection department, where the finish on the ends and the keyway are inspected and the diameter is measured to make sure that the gage will finish up to the required size.

The gage blanks are now ready for hardening. They are heated for hardening in a Leeds-Northrup electric furnace, Fig. 2, having a Leeds-Northrup temperature-recording potentiometer. This instrument shows by a curve, which it records, the exact decalescence temperature, and hence there is no need to determine exactly for each batch of steel whether it should be heated to 1375, 1400, or 1425 degrees F., for example, because the recording instrument shows for every heat when the moment has come for its removal from the furnace. Generally speaking, however, the steel from which these gears are made is heated to a temperature of about 1400 degrees F. for hardening, after which the gage blanks are quenched in oil and drawn to a temperature of about 325 degrees F., which is sufficient to relieve the strains produced in hardening.

Grinding Operations

The gage blank is now ready for the grinding operations. The hole is first ground to such a diameter that it will slip

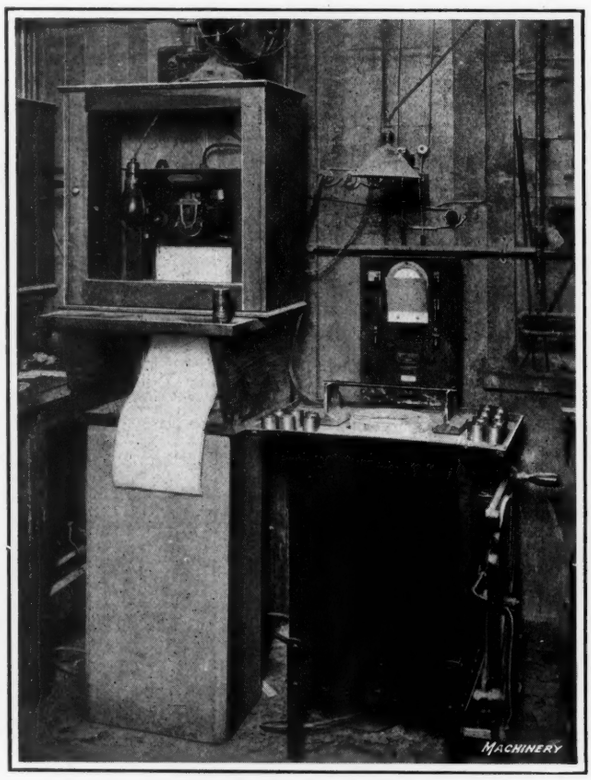


Fig. 2. Electric Furnace and Temperature-recording Potentiometer used in heat-treating Gages

freely, but not loosely, on the gage handle. After the hole is ground, the gage blanks are ganged up on arbors and are rough-ground on the outside without any regard to diameter, just merely to clean off the black color produced by hardening. The blanks are then given a heat-treatment which takes the place of the usual seasoning. In fact, this heat-treatment may be called an artificial seasoning process. It consists of heat-treating the blanks in oil to a temperature of 300 degrees F., after which they are cooled in oil, and then again heated in oil to 300 degrees F. and cooled. After this double heat-treatment, all internal strains are found to be relieved, and there will be no further changes in the steel due to its internal structure.

The blanks are now ready for finish-grinding, at which operation they are ground to within 0.0003 inch of the finished size, after which they are lapped to within 0.0001 inch above the actual stated gage size. The amount the gage is made over size allows for wear. The lapping is done with plain cast-iron ring laps, using flour emery and oil. From this operation the gages pass to the inspection room, where every gage is measured on a sensitive measuring machine capable of determining inaccuracies to within 0.00001 inch. As the gages are guaranteed to an accuracy of 0.0001 inch above the specified size, this machine makes it possible to easily detect any errors that would be greater than the guaranteed limit.

Manufacturing Snap Gages for "Grinding Sizes"

Another of the interesting types of gages manufactured by this company is the snap gage for "grinding sizes," which is made to provide proper limits on work that is turned preparatory to grinding, and which is based upon careful investigations as to the best practice in this respect. These gages are of the limit gage type as illustrated in Fig. 4, and are provided with three classes of tolerances according to the size being gaged. For work up to 1 inch in diameter the maximum size is 0.012 inch and the minimum 0.008 inch larger than the finished diameter of the work. For sizes from 1 to 2 inches, the limits are plus 0.014 and plus 0.010 inch; and for sizes over 2 inches, the limits are plus 0.015 inch and plus 0.010 inch.

The object of these gages is to provide a simple means for gaging work that is turned preparatory to grinding. No further thought need be given to the allowance necessary, if these gages are used. Suppose a shaft is to have a finish-ground diameter of 1½ inches. All that is necessary to provide the proper allowance for grinding when this shaft is being turned is to use a "grinding size" limit gage, which,

Fig. 3. A View in the Gage Inspection Department of the Taft-Peirce Mfg. Co.

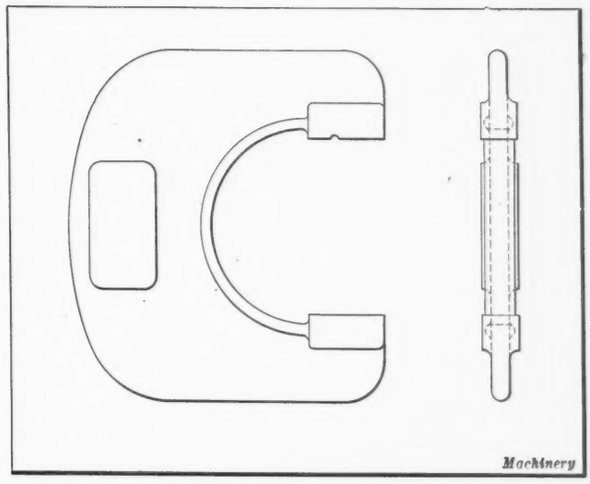


Fig. 4. Type of Limit Snap Gage for "Grinding Sizes"

in the case of the 1½-inch shaft will insure that the shaft will be turned within the limits 1.510 and 1.514 inches, and this will provide the proper allowance for the subsequent grinding.

These gages are made from soft machine steel forgings and the various operations that they pass through during the process of manufacture are as follows: (1) inspect drop-forging; (2) snag drop-forging; (3) straighten forging; (4) rough-grind to thickness; (5) inspect grinding and surfaces exposed by the grinding operation; (6) mill gaging jaws and front side of gage square with the surfaces previously ground; (7) file off burrs; (8) mark; (9) sand-blast to produce smooth surfaces; (10) carburize; (11) harden; (12) clean and submit to Barff finish; (13) finish-grind sides and gaging surfaces; (14) inspect grinding operations; (15) lap gaging surfaces with flat hand lap; (16) inspect gage size with Johansson blocks and put in stock.

The adjustable limit gage made by this company, having two gage points that may be set for any required limits or tolerances, is produced by the same operations, with the addition of the drilling, threading, and counterboring operations required for the holes holding the adjustable gaging points; these operations are performed between Operations (6) and (7) in the preceding list.

* * *

SUGGESTIONS TO BELT USERS

The following suggestions to belt users are contained in a recent catalogue published by the Chicago Belting Co., Chicago, Ill.:

In order to obtain a given amount of power, it is better to use a narrow belt running at a high speed than a wide belt running at a low speed.

If possible, use a belt speed of about 3000 feet per minute, but not more than 3600 feet per minute.

Use a pulley that is wide enough so that a small amount of irregularity in the belt does not make it run off. Allow at least one-half inch on machine pulleys and one inch or more on countershaft and lineshaft pulleys. Use crowned pulleys wherever possible.

If possible, use a horizontal belt with large center distances and with the pulling side at the bottom. In a horizontal drive, the slack side of the belt at the top of the drive increases the belt contact.

When using a vertical belt, do not have more center distance than is absolutely necessary, because the weight of the belt reduces the efficiency of the drive.

Avoid crossed belts on short center distances. Avoid the crossing of wide belts. If it is necessary to cross belts, see to it that the rubbing of the belt surfaces does not have a tendency to open up the laps.

Keep belts flexible and as clean as possible. Do not use belt dressing containing mineral oils or resins.

HORSEPOWER CHART FOR GEAR TEETH

By WILLIAM W. GAYLORD

The horsepower chart for gear teeth published in the May, 1919, number of MACHINERY, page 820, will be found very valuable as a time-saver when calculating the horsepower requirements of gear teeth. In calculating horsepower by the use of this chart, the required values are substituted in the following formula:

$$\text{H.P.} = \frac{2\pi RNW}{33{,}000}$$

where R = radius of pitch circle in feet;
N = number of revolutions per minute;
W = safe working load in pounds.

The value $2\pi RN$ equals the velocity in feet per minute, and W the safe load as found from the chart; therefore these two values, if substituted in the above equation, will give the horsepower. This is a simple calculation, but if a number of gears are to be figured, an auxiliary chart, as shown, will greatly reduce the amount of time consumed, by eliminating all calculations and enabling the horsepower which the gear is capable of transmitting to be read directly.

For the purpose of finding the velocity in feet per minute, it will be noticed that in addition to the pitch line speed or velocity scale, the chart also includes scales for pitch diameter, and revolutions per minute. The value $2\pi RN$ can be directly found by drawing a line through these two scales and extending it to the velocity scale, as shown. From the point where this line intersects the velocity scale, a line is then drawn to scale W—the safe working load scale—to the point representing the load determined from the previously published chart. This line will pass through the horsepower scale from which the horsepower may be directly read.

Example—If the identical conditions given in the previous problem are taken, the gear will have 30 teeth, 3 diametral pitch, 5-inch width of face, 10-inch pitch diameter, and will revolve at 690 revolutions per minute, or with a pitch line speed of 1800 feet per minute. From graduation 10 on scale D in the accompanying chart, draw a line to graduation 690 on scale N and continue it until it intersects scale V, which in this case will occur at point 1800. The load W, as determined from the previously published chart, for this particular condition is 3200 pounds, so that if a line is drawn from the graduation 1800 through point 3200 on the

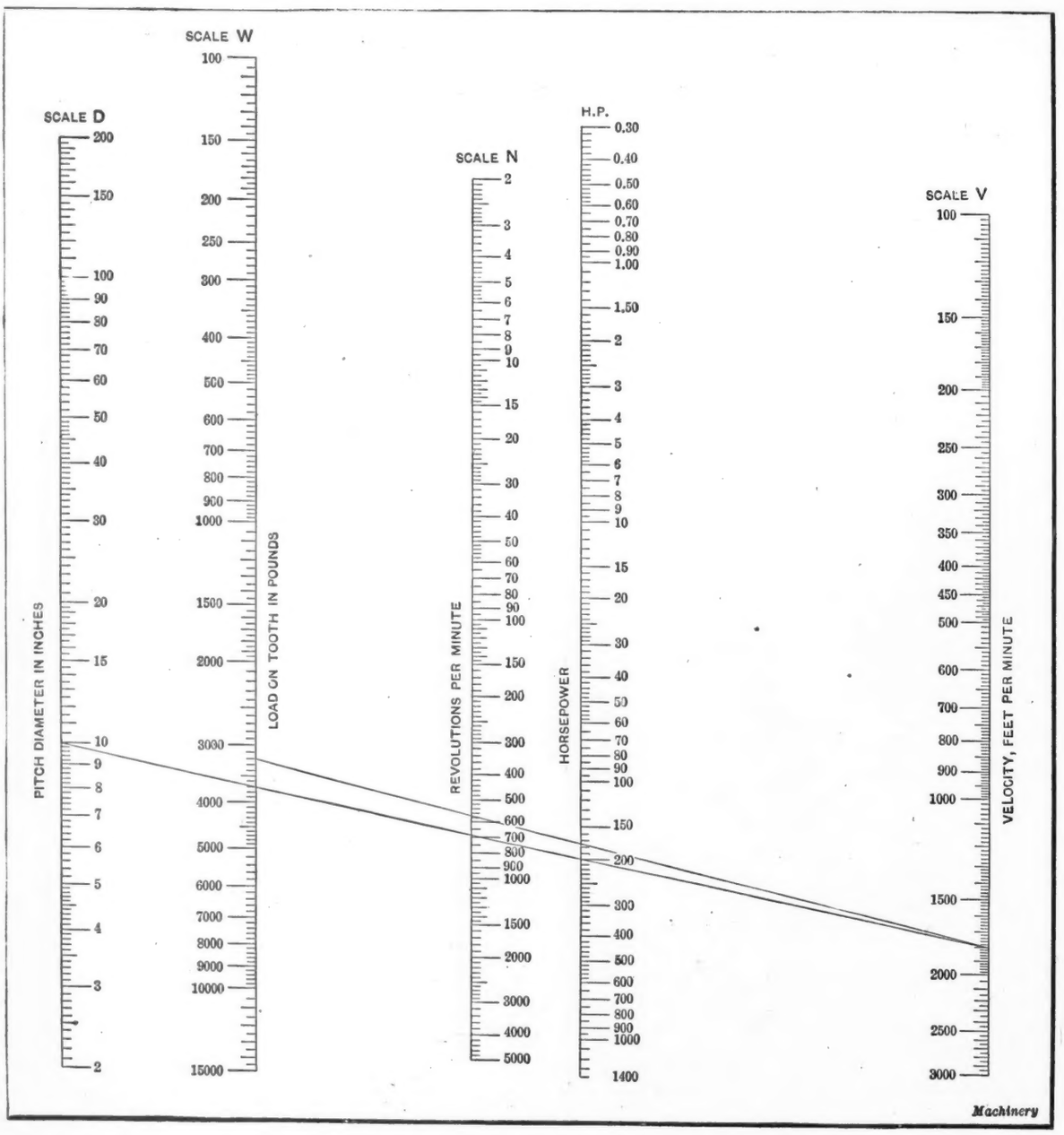


Chart from which Horsepower transmitted by a Gear can be read when Load is known

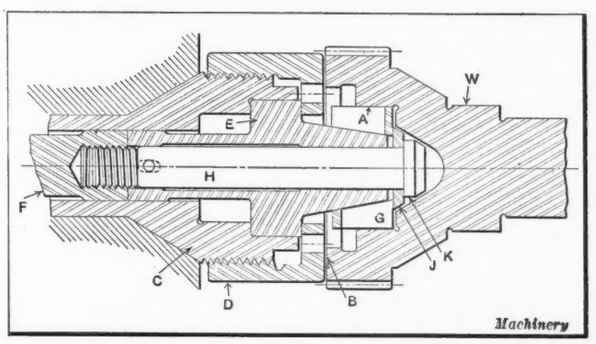
scale W, it will pass through the horsepower scale at point 175, as shown in the accompanying illustration.

The chart can also be used to find the diameters of gears which will give any surface speed for any known number of revolutions per minute. Referring to the chart previously published, the writer has satisfactorily used a piece of tracing cloth with a fine line ruled on it which is laid on the chart and lined up with the required values on the S_v and y scales. The intersection of a line (which, if drawn, would pass through the given values on scales f and p) with the axis m is then marked with a sharp pencil. The intersection of a line connecting this latter point and the point where the ruled line crosses axis n, with scale W, enables the required result to be obtained without defacing the chart, and the method is quite accurate and satisfactory.

* * *

EXPANSION ARBOR

The special expansion arbor, of which this article is the subject, was designed to hold a clutch shaft, similar to the one indicated at W in the accompanying illustration, by gripping the work at surface A. The nature of the work is such that the operation of expanding the arbor must be accomplished from the end of the spindle opposite the work-holding end, the surface B of the work being abutted against the retaining ring D for the purpose of insuring endwise location for the machining operation. This retaining ring



Special Expansion Arbor operated by Handwheel on Draw-back Spindle

is screwed on the inner spindle of the lathe or grinding machine, shown at C, and when tightened it secures the expander E firmly in the machine spindle. The projecting end of the expander has a suitable taper which fits an expanding sleeve G, the diameter of which should be made to suit the internal diameter of the work. This expanding sleeve is split nearly through from each side, the saw cuts being located alternately with reference to the sides, as indicated. This arrangement provides for easy expansion. A threaded stud H fits the regular draw-back spindle F on the machine, and carries at the opposite end a collar-nut K and thrust washer J for the purpose of drawing the expanding sleeve on the tapered end of the expander. The operation of this arbor is simple, it being apparent that a partial turn of the draw-back handwheel first expands the sleeve within the work and then draws the face B against the ground surface of the retaining ring. By this means the work is firmly held and positively and accurately located, so that variations in machining operations on the work are reduced to a minimum.

B. S.

* * *

It is stated in a recent commerce report that the number of ships built in the United States and officially numbered by the Bureau of Navigation, Department of Commerce, during the year ending June 30, 1920, totaled 2135, having a gross tonnage of 3,695,234. This figure did not include twenty-three vessels having a gross tonnage of 39,507, constructed for foreign owners, which would make a grand total of 2158 vessels of 3,734,741 gross tons.

ROLLER BEARINGS ON TRUCKS SUPPORTING DIRIGIBLE HANGAR DOORS

The huge structural steel doors of the hangar being erected at Lakehurst, N. J., to accommodate dirigibles belonging to the United States Government, are mounted on trucks provided with unusually large roller bearing journal boxes, which were manufactured by the Railway Roller Bearing Co., Syracuse, N. Y. Each journal box weighs 392 pounds when assembled. The principal dimensions of the roller

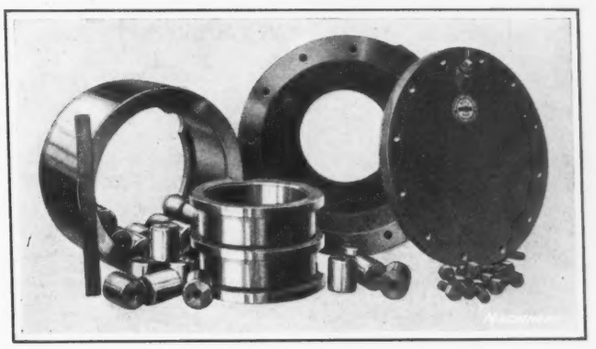


Fig. 1. Disassembled Roller Bearing Journal Box for Trucks supporting Dirigible Hangar Doors

bearings are as follows: Bore, 7 inches; outside diameter, 13½ inches; and width, 6½ inches. When the speed of the axles is one revolution per minute, the load capacity of each bearing is 45 tons. Fig. 1 shows one of the journal boxes disassembled.

An idea of the great size of the hangar doors will be obtained when it is stated that they are 135 feet high, 165 feet wide, 15 feet deep at the base, and weigh 3500 tons. Each door is mounted on four trucks which run on two standard-gage railroad tracks 165 feet apart. These trucks are driven by electric motors. Each truck is equipped with eight journal

Fig. 2. Set of Thirty-two Journal Boxes which is required for Each of the Four Hangar Doors

boxes so that thirty-two boxes are required per door. Fig. 2 shows a set of boxes for one of these doors, there being four doors to the hangar.

* * *

Steel castings are preferable for use in cases where a forging is unsuitable or too expensive and where combined strength and toughness are required. Cast iron is suitable for service in which the stresses are mainly compressive or where the stresses can be overcome by increasing the size of the casting regardless of the resulting weight. In many parts great weight for a given strength is desirable. Where extra strength and toughness combined with fairly good resistance to wear and fatigue are essential, a malleable-iron casting will suffice.

Production Engineering

By JOHN S. WATTS

THE demand for men capable of successfully filling positions of production engineers is becoming greater from year to year. To the writer's knowledge there has not been any attempt made to train the younger men for this important branch of the mechanical industry, and very little literature is available to assist the engineer in becoming proficient in this work. This is partly due to the fact that this work has only recently been recognized as an important engineering function; those who have taken up production engineering have generally been forced by shop conditions to assume these duties.

Since, without doubt, the work will become still more important in the future, it would be helpful to have more discussion of the subject in the technical magazines in order that engineers may become familiar with the functions of a production engineer. In this article, the subject is dealt with in a general way, pointing out the need for production engineering and the economies that result from its use.

Placing the Responsibility for Shop Planning Under One Head

The production engineer is the man responsible for planning the routing of the work through the shop, the sequence of operations, and the maintenance of a regular flow of material to each machine, insuring that when the parts arrive at the erecting floor, all the necessary material will be on hand in correct quantities. Under the old methods the responsibility for laying out the progress of the work through the shop rested with the shop foreman. With very rare exceptions his method of scheduling the work was to wait until a man finished one job before deciding which of the jobs waiting to be done should be undertaken next. This involved consideration on the part of the foreman as to which of the available jobs was suited to the particular man's ability and which of the jobs should be given preference. Frequently the waiting workman would be kept idle until the foreman had decided these points. Even after some particular job had been decided upon, more time would be spent in a discussion as to how the job should be handled.

This is not a criticism of the foreman because of his lack of planning, as his duties under the old method were numerous and left him no opportunity for planning in advance. He was required to pass judgment on all kinds of questions as they arose, and upon his ability to give a snap judgment depended the success or failure of the whole matter. In the majority of cases, the output under the circumstances was very creditable. Under present conditions, however, it is impossible for even the smallest shop to run to the best advantage without more planning of the work than has been usual in the past. Therefore, in every shop it is necessary for someone to perform the duties of a production engineer. If the plant is small, this man will be able to perform additional duties, but it is essential that the problem of routing jobs through the shop be given consideration.

Production Engineering for the Small Shop

The scheduling of work through a small shop presents in some ways more difficult problems than it does in the large shop, owing to the relatively greater variety of work handled and to the fact that there is a smaller number of men and of machines to choose from. For these reasons, the ability of the available mechanics becomes the vital point for consideration in distributing the jobs. In such shops it is necessary that whoever handles the scheduling must have an intimate knowledge of the ability of the men who are to do the work. The conclusion is, then, that in the medium sized or small factory it is seldom that anyone except the foreman would have the knowledge necessary to schedule the work successfully, but when thus burdened with production work he should be relieved of enough of his other less important duties to enable him to devote the necessary time to planning the work.

In actual experience the output of a moderate-sized machine shop has been increased more than 50 per cent by merely having the various jobs carefully planned ahead, choosing that work for each man at which he was most proficient, and having the next job with all essential information waiting at his machine before he had finished the previous job. In larger plants where a production engineer is employed, the work is scheduled to go to the machine that is most efficient for the particular job, and the foreman is responsible for obtaining the most suitable operator for the machine.

General Outline of the Method of Routing and Scheduling the Work

The end toward which the production engineer should work is to have every operation on every piece of work that is passing through the shop scheduled definitely and clearly both in regard to the machine which is to be employed and the time that it is to be performed; at least, the order in which the jobs are to be executed should be specified. The most desirable sequence of operations will usually be decided upon, and then, after estimating the time requirement for each operation, it is possible to distribute the work to the best advantage among the available machines so as to avoid overtaxing any of them. The best plan is to have the work so arranged that all the machines will be kept busy all the time.

The division of the work among the various machines demands careful consideration, especially when dies or special tools are required for executing the work. The reason for this is that generally, after the tools are made, it is difficult and expensive to transfer the work to another machine if it is found that the one chosen has been assigned more work than it can do according to schedule. The jobs should be run through in as large lots as possible to avoid changing tools too often, although some leeway must be had here, because if the lots are too large some unforeseen delay may prevent delivery to the erecting gang of some essential part and thus stop the work on the erecting floor. At the same time, this trouble is less likely to occur even with poor scheduling than it is with none at all.

It is surprising how many supposedly up-to-date plants are running the work through the shop with practically no planning, the infallible result being that some of the machines are loaded with a quantity of work beyond any possible output that can be expected from them, while other machines stand idle, thus seriously impeding the possible output of the plant. This condition usually results in a continuous rush to get out some part necessary to complete a job which may have been overlooked, and as a result the whole shop is thrown into a turmoil, trying to catch up with the erecting crew. To attempt to run any machine shop today without some kind of schedule is about as foolish as it would be to try to run a railroad without a time table. Furthermore, to wait until a man finishes one job before deciding on the next is on a par with a railroad on which the train crew has to stop at each station to find out at what place they stop next, if such a foolish thing can be imagined.

Advantages of Operating a Shop According to Schedule

There are numerous reasons for employing engineering methods in directing the flow of production through the shop. While at first sight, the labor and expense involved in maintaining a schedule may seem formidable, this is really not the case, since the economies that will be effected both in reduced costs and in increased output will return a big dividend on the expenditure. It is not necessary that the work, in order to pay for scheduling, be repetition work, for it has been the experience of the writer that it pays as well to schedule the work through a repair shop as it does through a manufacturing plant. The schedule for a repair shop must naturally be more elastic than it is in the manufacturing plant in order to allow for the occasional breakdown job which must be handled at once, but even then the schedule has its advantages in that it gives a better idea of the situation and shows which work can be laid aside to take care of the emergency job. It may seem on first thought that the breakdown of a machine would throw the whole schedule out of order, but this is not true, as with the information that was used in making the schedule, it is possible to rearrange it by transferring the work to some other machine, or to find out just what it is possible to do at short notice more readily and surely than can be done without this information. The schedule also shows the amount of time that may be consumed in repairing the machine without holding up production.

Keeping Production to the Maximum by Properly Assigning Jobs

It is common knowledge to those who have worked in the shop that a man will finish a job more quickly when he knows that the next one is waiting for him than he will when he does not know what he is to do next. This fact is especially noticeable when there happens to be a disagreeable job waiting to be performed that no one wants and everyone trys to avoid until it has been assigned. Many machine operators make a habit of lagging in their work at the end of a job, thinking that it is entirely up to the foreman to keep them busy, and as long as they can make an appearance of being at work they will not tell the foreman that they are ready for another job. Some will entirely refuse to report when through with a job, but depend upon the foreman to know, and to assign the next job when he gets around to deciding what it is to be.

This leaves all the responsibility of knowing just when each job is completed to the foreman. If a number of men finish their jobs at the same time, which often happens, a serious loss of time is incurred until the foreman can decide upon the next job for each, one after the other, and give each his instructions. Under these circumstances an error in judgment on the part of the foreman in distributing the work or in issuing instructions is very likely to occur. On the other hand, if a schedule were arranged, the foreman could distribute the work among the men without waiting for the completion of the various jobs.

The importance of, and the knowledge required for production engineering cannot be over-emphasized. It demands a thorough knowledge of all machines, machining operations, and time required to perform the work, as well as good judgment regarding general shop practice. The successful production engineer will not stop at the scheduling of the work, but will be able to assist the designing engineer in developing designs which can be most economically manufactured with the available equipment, thus avoiding the buying of new machines that cannot be kept in operation.

* * *

The largest rolling mill in the world is said to be one recently put in service at Dorman & Long's Warrenby mills near Durham, England. This is an electrically driven 42-inch plate mill of the reversing type. Each roll is 3 feet 6 inches in diameter and 9 feet 6 inches long, plates ⅜ inch thick or over, with a width of 9 feet and a length of 100 feet, being rolled.

TESTS FOR TOOL DESIGNERS

By ALBERT A. DOWD

The demand for draftsmen during the past year has been great, and some firms have been unable to secure enough men. Other firms have a full drafting-room force and yet are not able to produce the amount of work desired. The salaries of draftsmen have been very nearly doubled during the last three years, yet it is difficult to obtain capable men for certain kinds of work, notably tool designing. The colleges, trade schools, evening classes, and correspondence schools graduate a great number of men every year. These men have received a certain amount of training and have then been thrown on their own resources to make a living, with the expectation of receiving high salaries and easy work. The demand for men opens a door here and there until all the applicants have finally found positions. A certain number of these men possess some mechanical ability; others have very little, yet may develop into fair draftsmen in the course of time; the remainder will never become successful draftsmen. Quite a large percentage of these men branch out into other lines after a year or two.

The Importance of Actual Shop Experience

In the line of tool designing, however, many draftsmen lack practical shop knowledge, and consequently will never rise above mediocrity. At present all the courses in mechanical drafting or mechanical engineering include a certain amount of shop work. The men are taught how to run the various machine tools and are given several hours' actual practice in this line each week. To those men who have natural mechanical ability this practice gives a start in the right direction and a desire for this kind of work. It is not the purpose of the writer to belittle the efforts of colleges and trade schools in the matter of practical shop training. He believes that this is of the utmost importance to men intending to follow up mechanical engineering in any of its branches. There should be more of this shop training, and instructors should make it as practical as possible.

The weak points in the average tool designer's knowledge are largely due to lack of practical shop experience. A man may know how to turn a shaft or cut a thread using an engine lathe, yet he may do these things in a purely routine way, without the basic knowledge of the reasons why certain things are done. Very likely if he were asked to do the same piece of work on a turret lathe or screw machine, he would not know what kind of tools to use or how to use them. He might be able to operate a milling machine for plain work, but would not know when to use an end-mill, or when the use of plain milling cutters would be advisable. He may know what a jig or fixture is, but he may not thoroughly understand the principles underlying the design, and may never have used a drill jig or milling fixture. He probably does not know how to grind a drill or an ordinary forged tool. There are, of course, many good tool designers, but the problem which the employer is called upon to solve is whether or not an applicant has the necessary qualifications for the work required of him.

Usual Practice in Hiring Designers

The usual practice when hiring a designer is about as follows: The applicant is asked to fill out an application form or card, and is then hired or not, according to the more or less satisfactory record of his experience and references. The result is, in many cases, that after a trial he is found to be overpaid and his work generally unsatisfactory due possibly to a lack of shop experience or to insufficient mechanical training. However, this man is frequently kept at work because the employer is shorthanded and prefers to make the best of the situation rather than to take any chances with a new man.

The writer has hired several hundred draftsmen, detailers, and tool designers in the past five years, and realizes the

difficulty of picking men from a number of applicants so as to obtain those who are really suitable for the available positions. Sometimes a man applies and states that he has had a number of years' shop experience and a number of years' experience in designing jigs and fixtures; he states that he has worked for several concerns a number of years and gives references to these firms. The references prove to be all right and the man is put to work, but often is found to be deficient. The following questionnaire has been used in a number of cases by the Service Engineering Co., Inc., New York City, in connection with applicants for positions, and as a result a considerable saving of unnecessary expense has been realized.

Application Form and Questionnaire

An application form should be prepared for the prospective draftsman to fill out. This form should have provision for the applicant's name, address, age, nationality, etc., together with a list of firms for whom he has worked, and a space for the record of his shop experience, class of work, salary desired, etc. In addition to this more or less general practice, a series of test questions should be prepared to determine how much the man really knows about the business. Each employer can make his own list according to his needs, although some of the following may be used in selecting a tool designer. The questions marked (A) should be answered readily by a detailer on jigs and fixtures; those marked (B) by a designer; and those marked (C) by a checker or other high-class man of broad experience.

(A) 1. What is a drill jig and how is it used?
(A) 2. What is a milling fixture, and how is it used?
(A) 3. What is a finish mark and how is it used?
(A) 4. Give a sample of your lettering such as you would put on a drawing, using the following notations: "Drill jig for front axle, part number XE 157-T-243."
(B) 5. What kind of milling cutter would you use for surfacing a cast-iron block 2 by 6 by 18 inches?
(C) 6. What limits would you put on: (a) a one-inch diameter hole for good commercial work; (b) a one-inch diameter shaft which is to be a good running fit in the one-inch hole?
(B) 7. If you were making a drawing of a drill jig having eight (8) holes equally spaced around a 4-inch diameter circle (a) what dimensions would you give to locate the holes? (b) Give the formula you would use in figuring the dimensions.
(B) 8. What are the following gages used for: (a) snap gage; (b) plug gage?
(B) 9. (a) From what material would you make a 2-inch slip bushing? (b) How would you harden it?
(B) 10. (a) Extract the square root of 31784. (b) Extract the cube root of 913496.
(B) 11. (a) Find the circumference of a circle having a diameter of 0.750 inch. (b) Find the area of this circle.
(B) 12. What machine would you use to broach a 1-inch square hole?
(C) 13. If a shaft is to be hardened and afterward ground to 1.000 inch diameter, to what diameter would you turn the shaft before hardening?
(B) 14. In making a jig or fixture for a rough casting, how many fixed points of support would you provide?
(C) 15. A piece of machine steel 4 inches in diameter is revolving at 52 revolutions per minute. What is the cutting speed in feet per minute? Does this speed conform to modern practice?
(B) 16. Can you read a micrometer? If so, what measurement would a one-inch instrument indicate if the figure "3" appeared on the stationary portion, and the mark on the revolving sleeve showed "21"?
(A) 17. How many cubic inches in one cubic foot?
(B) 18. What is the ordinary draft on a forging?
(B) 19. In cutting the teeth on spur gears, what kind of machines are commonly used? Mention at least two types.
(B) 20. What is the difference between a bevel gear and a miter gear?
(C) 21. What kind of steel would you use for (a) clamps in jig work; (b) small bushings; (c) V-blocks; (d) clamp screws? (e) Would you harden any of these, and if so how?
(B) 22. How much clearance would you provide on all sides of the work in making a drill jig for a rough casting
(B) 23. Have you had any experience in turret lathe or screw machine work? If so, answer the following questions: (a) If you were to machine a 2.000 ± 0.001 inch diameter hole in a cast-iron flywheel, on a turret lathe, and the hole were cored to 1¾ inches in diameter, what tools would you use? (b) What tools would you use in reducing a 2-inch shaft to 1 inch diameter on a turret lathe?
(B) 24. Make a sketch to illustrate a method by which you could clamp four (4) round bars 1 inch in diameter at one time, using but one screw or lever.
(B) 25. What is an interlocking milling cutter and how is it made?
(B) 26. Did you ever make a punch and die? If so, what is the stripper plate used for?
(B) 27. What kind of machines are used for punch and die work?
(B) 28. Can you use a slide-rule?
(B) 29. Have you ever designed automatic machinery? If so, what type of machines and for what purpose?
(B) 30. What machine would you use in cutting a shaft to receive a Woodruff key?
(C) 31. In making a dovetail slide like the cross-slide of an engine lathe, would the final fitting be done by machinery or by hand?
(B) 32. Of what use is a taper gib in a movable slide?
(B) 33. Do you know much about automobile tools? If so, state the common practice for final finishing the inside of motor cylinders.

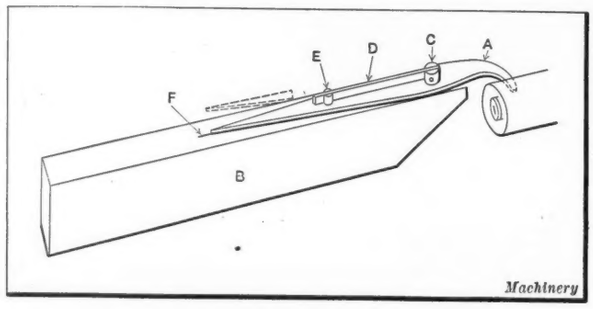
The above list is only a suggestion which may be used as a basis, and adapted to suit the judgment of the user. It has been found, in hiring men with the aid of a questionnaire, that with a little judgment it is possible to classify a man and readily determine whether he has had the experience which he claims. In using a series of test questions of this kind, it is suggested that they be put to the applicant verbally, selecting such questions as may be considered advisable.

* * *

INDICATOR FOR CENTERING WORK

By ADOLPH GRIMM

The accompanying illustration shows an indicator that will be found useful for centering work in the lathe. This tool can be easily made by the machinist, and if carefully constructed will produce sufficiently accurate results. The indicator is designed to be held in the toolpost of the lathe, and used in the usual manner. The indicating lever *A* is

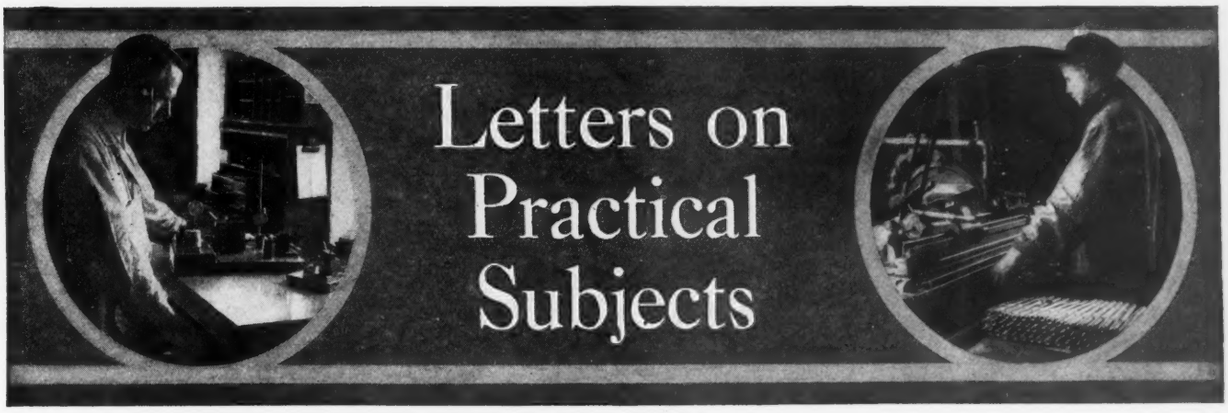


Indicator for Use in centering Work in the Lathe

pivoted on shank *B* by means of a shoulder screw or pin *C*. Spring *D* may be made either of flat stock or of music wire, and is fastened to the pivot screw *C* so that its opposite end will act upon pin *E*, carried on the indicating lever. The tension of this spring is such that when the tool is not in use the indicating arm will occupy the position shown by the dotted lines. The leverage ratio may be increased or decreased as desired, according to the quality of the work being handled.

* * *

An alloy consisting of 95 per cent aluminum and 5 per cent magnesium is used by the Westinghouse Electric & Mfg. Co. for starting-motor frames and other automobile work where extreme lightness and good machining qualities are necessary. The specific gravity of this alloy is 2.47, the average tensile strength approximately 27,000 pounds per square inch, and the elongation about 3 per cent in two inches.



RECORDS OF MACHINE TOOL EQUIPMENT

The maintenance of records giving the specifications and important dimensions of machine tool equipment in the shop will be of value to the concern, although this fact is not appreciated by all. Such a record is of help in connection with the designing of jigs and fixtures, and as a means of determining at a glance whether or not newly designed parts can be machined on the equipment available in the shop. To be able to refer to a record and obtain immediately such valuable information as, for example, the size of the slots in a machine table or the diameter of a boring mill table, is a great deal easier and requires less time than the old method of making a trip to the shop as the occasion arises for the purpose of taking the required measurements.

The writer has prepared machine tool equipment records by making tracings such as shown in the accompanying illustration, from which blueprints were made and fastened together in a loose-leaf binder. The illustration shows the idea that would be followed for each machine in the shop. In so far as possible these data sheets were made by tracing the outline of the machines from a catalogue, and incorporating drawings of machine tables, dimensions of slots in the table, and other similar sketches, together with tabulated items such as shown in the illustration. These sheets are arranged numerically in the loose-leaf binder to agree with the number of the machine. As this record shows the weight of the machine, size of motor, width of belts, countershaft specifications, and other similar information, it is evident that the reference sheets will be of value to other departments than the designing department.

Cincinnati, Ohio — HOWARD E. DARBY

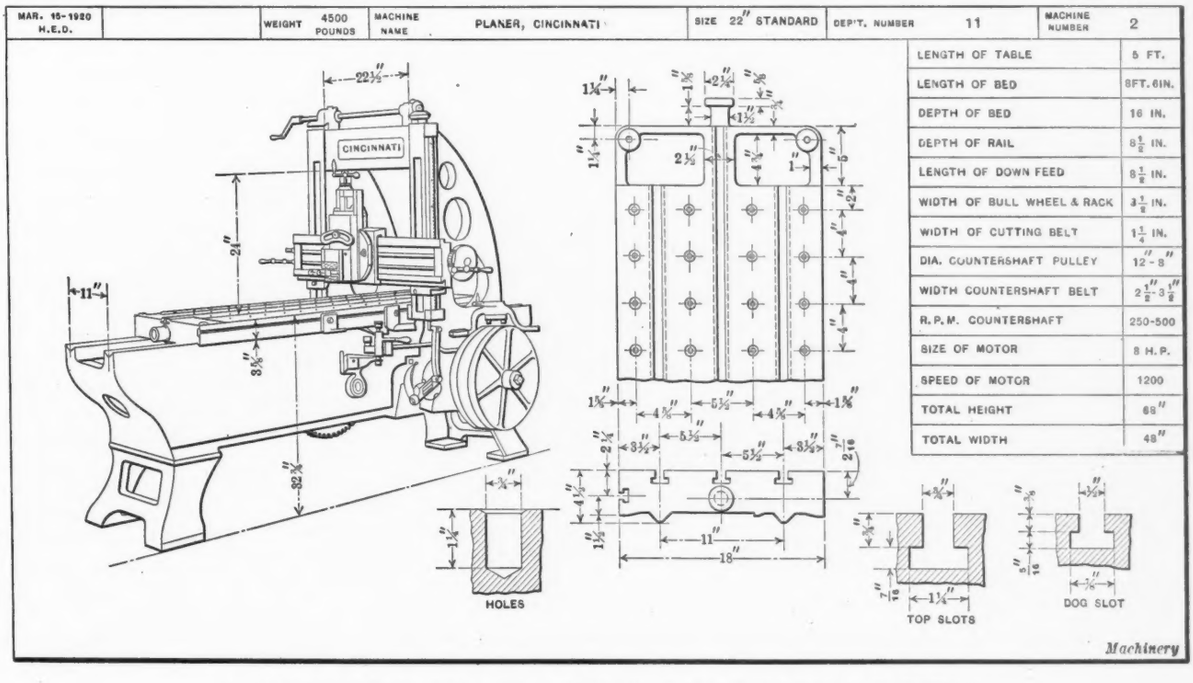
APPROXIMATE MILLIMETER EQUIVALENTS FOR FRACTIONS OF AN INCH

The number of millimeters equal to fractions of an inch is given to four decimal places in MACHINERY'S HANDBOOK. For many purposes, however, an approximate equivalent given to one decimal place is sufficient. If it is assumed that 25.6 millimeters are equal to one inch, rather than the actual 25.3995 millimeters, a number is obtained which permits ready subdivision for determining the number of millimeters, and decimal parts thereof, equal to fractions of an inch. On this basis:

25.6 millimeters = 1 inch	1.6 millimeter = 1/16 inch
12.8 millimeters = ½ inch	0.8 millimeter = 1/32 inch
6.4 millimeters = ¼ inch	0.4 millimeter = 1/64 inch
3.2 millimeters = ⅛ inch	0.2 millimeter = 1/128 inch

These metric equivalents can be easily remembered, especially the number of millimeters corresponding to 1/16 inch, and the values given are sufficiently accurate for many ordinary uses.

Auckland, New Zealand — FRED H. HADFIELD



Sample Loose-leaf Binder Sheet containing Specification Data of Special Value to the Draftsman

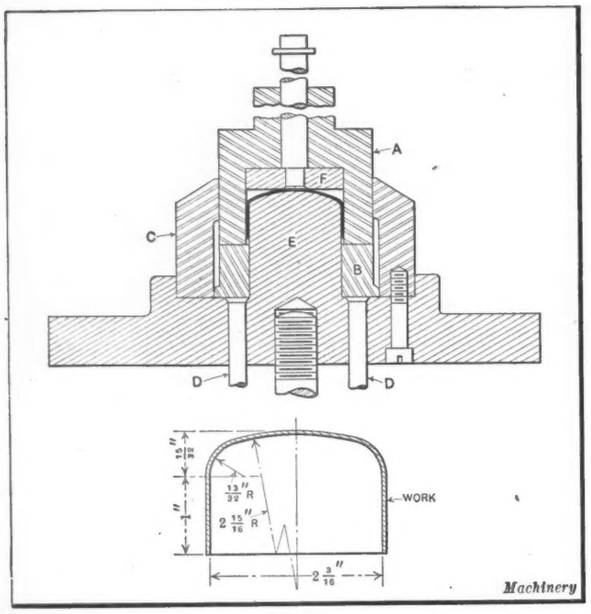


Fig. 1. Combination Blanking and Drawing Die used in First Operation on Door Knob Shell

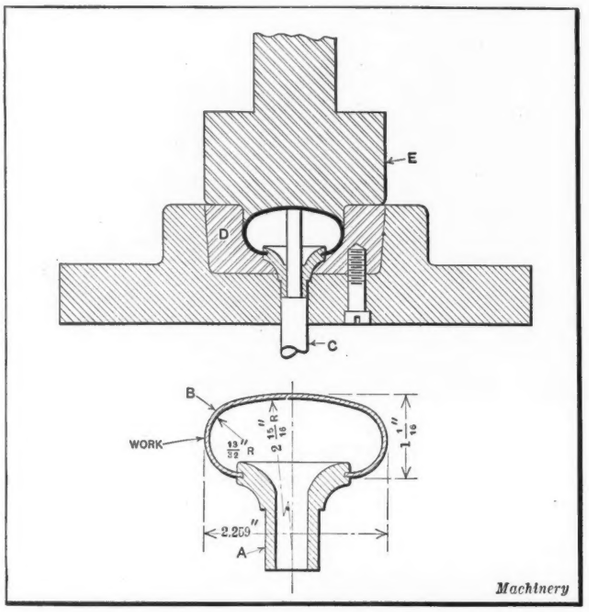


Fig. 2. Die employed to complete the Shaping of the Shell and to force it on the Shank

DIES USED IN THE MANUFACTURE OF DOOR KNOBS

The dies described in the following article are employed in the production of door knobs of the type shown beneath the die in Fig. 2. This door knob consists of a cast-iron shank *A*, which is finished on various machines, and shell *B*, which is formed to the desired shape and forced on the shank by means of two dies which are illustrated in Figs. 1 and 2. Shell *B* is produced from sheet brass, 0.036 inch thick, the diameter of the blank being 3¾ inches.

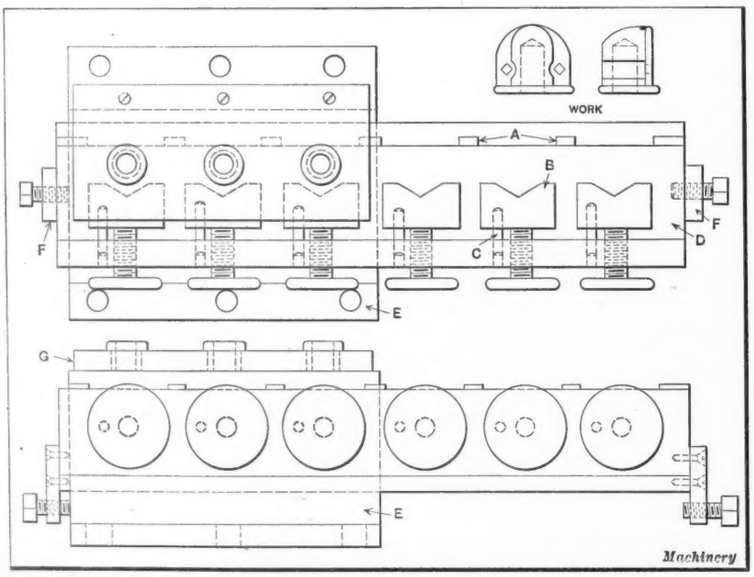
The first operation on the shell is performed by the combination blanking and drawing die shown in Fig. 1; this illustration shows the positions of the various moving parts at the completion of the downward stroke of the punch press ram. Prior to the downward stroke, punch *A* is in a position above the die, and drawing ring *B* is also in a raised position, its upper surface being in the same plane as the upper surface of die ring *C*. This is accomplished by means of pins *D*, which are actuated by a rubber buffer of standard design. The brass strip from which the blank is cut is placed on the upper surface of the die ring *C*, and is blanked to the proper size by punch *A* as it passes the cutting edge of the die ring on the downward stroke. The shell is then drawn to the proper shape by the forming die *E* as the punch continues to descend, forcing drawing ring *B* downward at the same time. The pressure between the punch and the drawing ring is sufficient to prevent wrinkles from being formed on the shell in this operation. A knock-out device *F* is provided to force the shell from the punch when the punch is raised from the die. The removal of the shell from the die is easily effected by drawing ring *B* when it is raised to its normal position by pins *D*.

The second and final operation on the door knob is performed by the die illustrated in Fig. 2. At the beginning of this operation, rod *C* is in a raised position, and shank *A* and the shell produced in the first operation are placed on it. The position of rod *C* is such that when the shell is placed on it, the lower portion of the shell extends into the die ring *D*. It is evident that as punch *E* descends on the downward stroke, the work and rod *C* are forced into the die. This movement causes the lower portion of the shell to be rounded to the same shape as die ring *D*, and forces the edge of the shell into a corresponding groove on the periphery of the largest portion of the shank. The removal of the completed door knob from the die is an easy matter, because it is raised with rod *C* when the rod is returned to its original position.

Toledo, Ohio J. BINGHAM

MULTIPLE DRILL JIG

The drill jig described in this article was used on an old-style three-spindle drilling machine, being designed especially to agree with the center distances of the drill spindles. This machine was worm-driven and equipped with a power feed for raising the table to the drills. The work for which the jig was designed is shown in the upper right-hand corner of the accompanying illustration, and is a cast-iron caster bracket which has no machining operations performed on it except the drilling of one 37/64-inch hole, 1⅜ inches deep. This casting has a flange by means of which it hangs on



Drill Jig with Sliding Carriage for Use on Multiple-spindle Drilling Machine

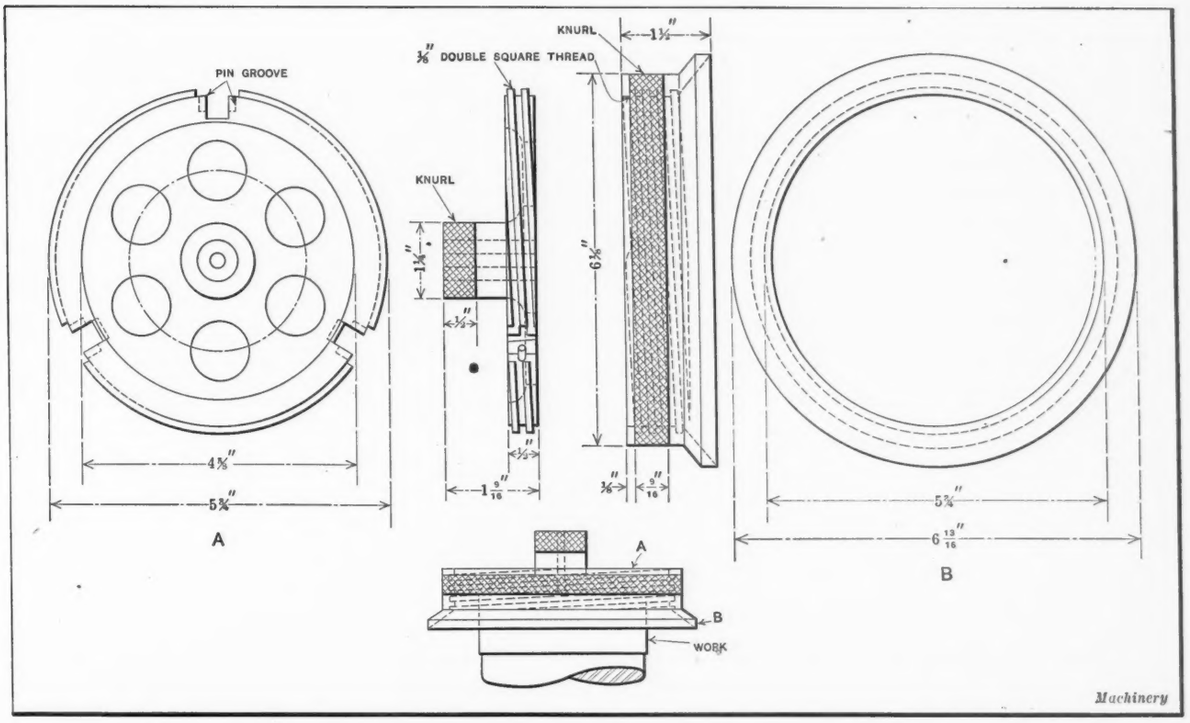


Fig. 1. Principal Details of Centering Jig and Method of Application to the End of the Work

the rear upright part of carriage *D*, being located between locating blocks, such as shown at *A*. The carriage is fitted to the base *E* by means of a tongue and groove slide, so that after the jig has been clamped to the machine table with the drill bushings in line with the spindles, the carriage may be slid from end to end, so as to bring the right-hand end under the bushing plate *G*. The front upright portion of the carriage is tapped for hand-screws, to the end of each of which a V-block *B* is fitted. Guide pins *C*, which are a press fit in the V-blocks and a loose fit in the carriage *D*, are employed to guide the blocks as they are being operated by the hand-screws, when clamping and releasing the work. The end-stops *F* are provided for the purpose of limiting the travel of the carriage.

In operation, it is apparent that the workman first clamps and drills three parts in the first half of the jig. While these castings are being drilled, the operator inserts three more in the empty sections of the jig, following which, as soon as the feed is cut off after drilling the first three, the jig is indexed by sliding the carriage along the base until the three newly loaded parts are brought into position under the drill bushings in bushing plate *G*. The finished work may then be readily removed and the jig reloaded while the table is again being fed up to the drills. Although this jig does not employ any mechanical means for holding the carriage or for preventing it from moving during the drilling operation, some form of indexing pin or locking device could be used to accurately locate and secure the carriage. Obviously the capacity of the jig may be increased so as to be used on multiple-spindle drilling machines of six spindles or more.

Cicero, Ill. JOHN J. BORKENHAGEN

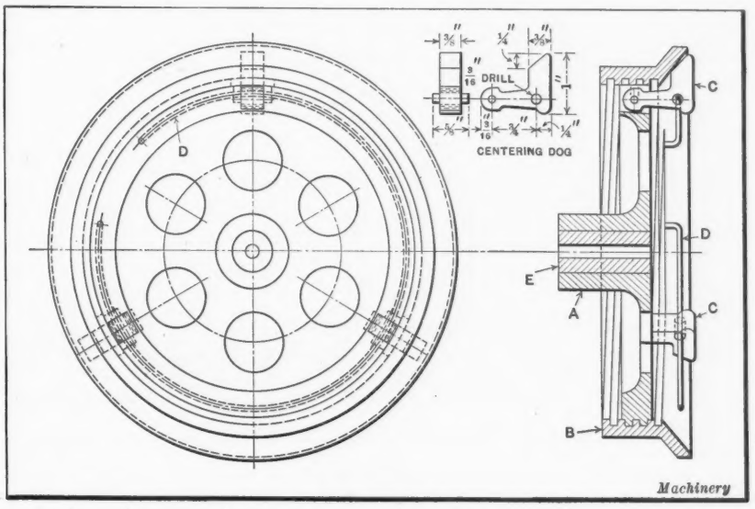


Fig. 2. Assembly of the Jig showing Relative Position of Parts, also Detail of Centering Dog

CENTERING JIG FOR CROSS-HEAD AND KNUCKLE-JOINT PINS

Cross-head and knuckle-joint pins are usually made from bar stock and are not provided with centers. On locomotive repair work it is essential that some means be provided for centering these pins; consequently the jig here described was designed for the purpose of drilling the centers in the large ends. The principal details of the jig are shown in Fig. 1, as well as its application; while in Fig. 2 the general arrangement may be seen by referring to the sectional view at the right.

The tool consists of a flanged steel ring *B* provided with double square threads on the inside and knurled on the outside to facilitate handling. The hole on the flanged side of the ring is tapered, the purpose of which will presently be explained. Disk *A* is provided with a casehardened steel bushing to accommodate the drill used in centering the work. This bushing may be seen at *E*, Fig. 2, from which it will be apparent that it fits in the knurled hub of the disk. Three slots, spaced equally around the periphery of the disk, are provided to receive three centering dogs, such as shown

in detail in Fig. 2 and indicated in the assembly at *C*. The slots in the disk are machined with a pin groove on each side to accommodate the trunnions on the dogs. Before these dogs are assembled in the disk, they are strung on a brass wire spring *D*, which forms a three-quarter circle, the diameter of which for this size of tool is about 6¼ inches. When disk *A*, carrying the three dogs supported at the heel by this special spring, is screwed into the steel ring *B*, the dogs will bear against the previously mentioned tapered hole in the ring so that they are swung radially toward the center. The further the disk is screwed in, the greater the compression of the spring becomes, until at its greatest contraction the ends nearly meet. The relative position of the dogs and the spring when the disk is screwed about half way in, may be seen in Fig. 2. From the foregoing discussion, it will be apparent that in using the jig it is only necessary to place it over the end of the pin, the dogs adjusting themselves to the circumference of the work and centralizing the jig automatically as the disk is tightened. This brings the drill bushing to the center of the pin as determined by the three points of contact at the circumference.

NORMAN MCCLEOD

DETERMINING PROPER EXPOSURE FOR BLUEPRINTS

The variety of shades of blue that prints made from tracings and bond drawing paper may have is very great. Discussion often occurs in the drafting-room as to the proper color and the best way to obtain it. By noting the color on the margin of the print that projects beyond the edge of the tracing, the question as to the amount of time allowance for making the print can be determined. If this margin is lighter than the body of the print, approximately the correct amount of exposure has been given the print; if it is darker than the body of the print it shows under-exposure; and when the margin has a greenish yellow appearance, the body will be mottled and the lines narrow and faint—an indication of over-exposure. Bond paper requires a longer exposure than tracing cloth.

Baltimore, Md. HENRY R. BOWMAN

INDEXING MILLING FIXTURE

For the purpose of squaring and slotting the automobile drag-link adjusting screw shown at *A*, Fig. 1, a special indexing fixture was designed by means of which the work was performed in one operation. This indexing fixture has proved efficient, and its design is such as to be applicable to a wide range of work. The fixture is illustrated in Fig. 2, from which it will be seen that two sets of cutters are employed. The turret of the fixture, which indexes on the base, carries four work-holding stations, located equally from the center of rotation and 90 degrees apart. In operation, the work is loaded at station *A;* then the fixture is indexed 90 degrees to station *B* where two sides of the square are milled. The fixture is then indexed another 90 degrees to station *C* where the two remaining sides are milled and the slot cut, simultaneously. While the work at station *C* is being completed, another part is being machined at station *B*. On the next indexing movement of the fixture the completed part arrives at station *D* and is removed by the operator. From then on the operation of the fixture is simply a repetition of loading and unloading one piece at stations *A* and *D*, respectively, while the two pairs of cutters are simultaneously at work on two other pieces.

In connection with the application of this general type of fixture for machining other similar work, attention is directed to the two parts shown in the lower part of Fig. 1, both of which have recently been produced in large quantities. A fixture operating on the principle described could have handled these parts with better results than were attained with the tools used. The parts are shown as an aid to the reader in adapting a fixture of this kind to his requirements, the surfaces shown by heavy lines being those which can be machined in one operation. The radius *R*, Fig. 2, should be large enough so that the operator can load and unload safely.

E. C. COOLEY
Syracuse, N. Y.

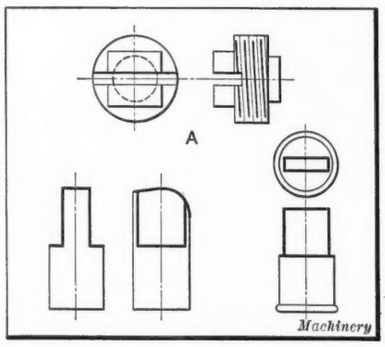


Fig. 1. Types of Work which may be advantageously machined on a Fixture of the Type shown in Fig. 2

BORING TOOL OR DRILL FOR FLAT-BOTTOMED RECESSES

A tool designed by the writer for rough-boring a recess in the base of a high-explosive shell is shown in the illustration accompanying this description. This cutter can also be employed in performing similar operations on a large variety of work. The shell was mounted in a turret lathe for the operation, the blunt end of the cutter being held in a simple holder (attached to the turret) having a slot extending across the front end, and two set-screws. Best results were obtained by having the turret slightly loose, thus permitting the cutter to float, and by using a hand feed.

In making the cutter, a piece of high-speed steel, 2½ inches wide by ½ inch thick and 2 inches long, was milled on the narrow sides until the distance across the corners was 2⅛ inches—the diameter of the recess to be bored in the shell. A line was then scribed across the top of the blank between two opposite corners, after which the cutter was set up on an angle in a milling machine vise and the front faces or "lips" were milled out as shown, by using a round-cornered milling cutter. Sufficient metal was then removed from the narrow sides to afford a generous clearance, there

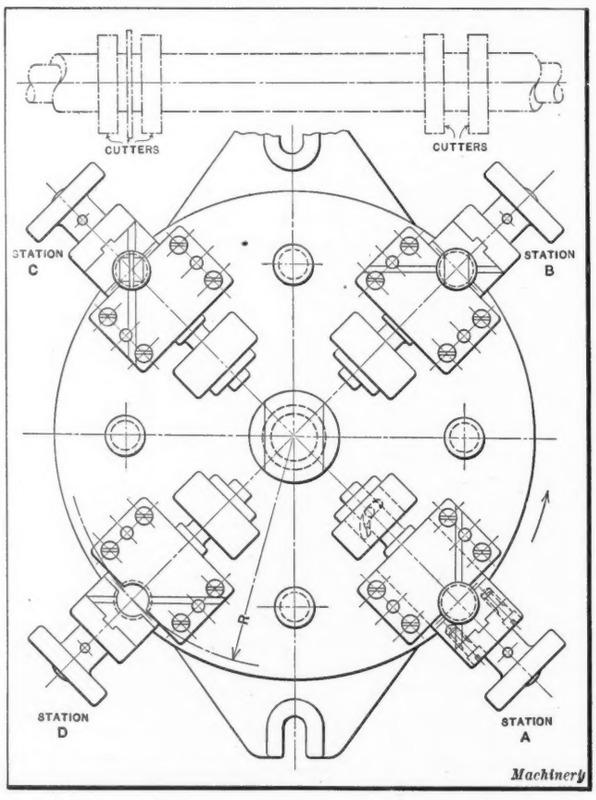
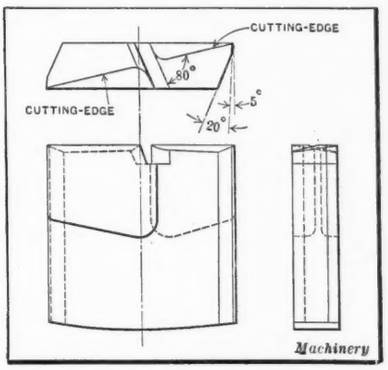


Fig. 2. Indexing Fixture designed for Use in milling and slotting Drag-link Adjusting Screws for Automobiles



Cutter for boring Square-bottom Holes

being a land ⅛ inch wide left. This land was also machined at an angle of 5 degrees for clearance purposes. The metal backing the cutting edges was machined at an angle of 7 degrees from the horizontal plane of the cutting edges. The cutter was next hardened, and the gash on the cutting edge ground.

The cutter was held in the vise on a grinding machine for the operation, the center line of the vise being set to an angle of 10 degrees with the grinding wheel so that the gash was ground at an angle of 80 degrees with the cutting edges. A saucer wheel was used, the angular side of the wheel being placed toward the longer of the two cutting edges. In this manner it was possible to grind the gash to such a depth that the right-hand end of the longer cutting edge terminated at the exact center of the cutter. This is an important requisite in a tool of this type in order to insure proper cutting action.

It will be noted that the end of the cutter held in the holder is slightly rounded, this condition permitting the cutting edges to square themselves with the surface of the work. A coolant should be used in connection with this cutter. The cutting edges can be readily reground by hand on a fine-grained emery wheel, but care should be taken to grind them in a straight line across the center of the tool.

Allentown, Pa. JOE V. ROMIG

FORMULA FOR SOLVING AN INSPECTOR'S PROBLEM

Some time ago the writer had occasion to inspect a number of pieces having the outline shown in the accompanying diagram. It was a comparatively simple matter to check the dimensions D and L and angles A and B, but the checking of the dimension X from the top of the part to the intersection of the two surfaces which constitute each side of the part could not be readily accomplished on account of these surfaces being joined together by an arc of which R was the radius. Tolerances were allowed on angles A and B and, of course, dimension X varied as these angles varied. Subsequently, a formula was evolved for determining this dimension after dimensions D and L and angles A and B were known.

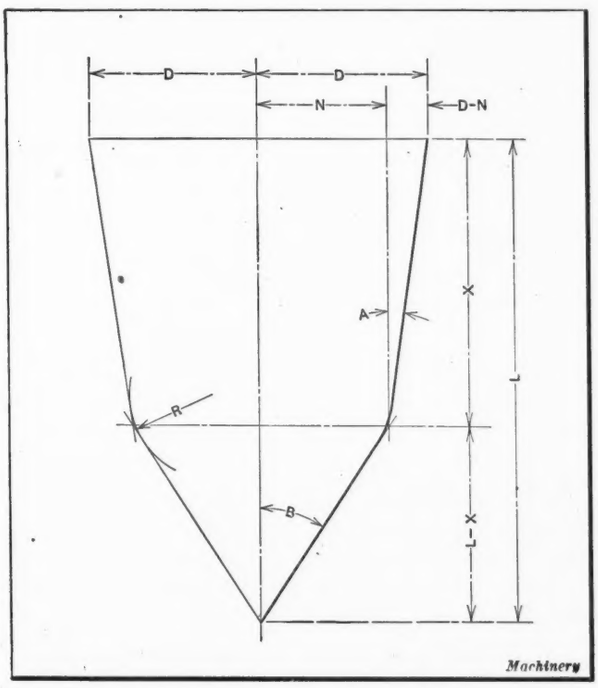


Diagram used in evolving Formula for checking Dimension X

Referring to the illustration,

$$\frac{D-N}{X} = \tan A$$

and

$$N = D - X \tan A$$

Also

$$\frac{N}{L-X} = \tan B$$

and

$$N = \tan B\ (L - X)$$

Therefore

$$D - X \tan A = L \tan B - X \tan B$$

Solving,

$$X\ (\tan B - \tan A) = L \tan B - D$$

$$X = \frac{L \tan B - D}{\tan B - \tan A}$$

It will be seen that this formula can be applied to a large variety of work where similar conditions are met with.

Philadelphia, Pa. FREDERICK J. NAAB

* * *

FEDERAL FUNDS FOR RE-EDUCATION OF THE INJURED

According to an act recently passed by Congress, federal funds will be expended in the various states for the rehabilitation of persons injured in industrial work. The amount allowed by Congress to each state must be equalled by state funds. An appropriation of $750,000 has been made by Congress for the present fiscal year, and $1,000,000 has been pledged for each of the next three years. The funds will be apportioned in proportion to the population of the states. Up to this time six states have accepted the federal cooperation, three through the action of the legislatures and three by the act of governors. The states that have acted through their legislatures are Minnesota, Nevada, and New York, and those in which the act has been accepted by the governors are Tennessee, Arizona, and Indiana. It is expected that other states will take similar steps to accept federal aid as soon as their legislatures meet. Those permanently disabled in industrial occupations from amputations of the hand, arm, leg, feet, or a total loss of sight of one or both eyes have been estimated to total more than 14,000 a year. Although accurate figures are not available upon which to base calculations, a rough estimate places the figure for the number of persons who will be re-educated each year under the act at from 100,000 to 200,000. The federal board of vocational education will help the states to formulate the best rehabilitation methods.

* * *

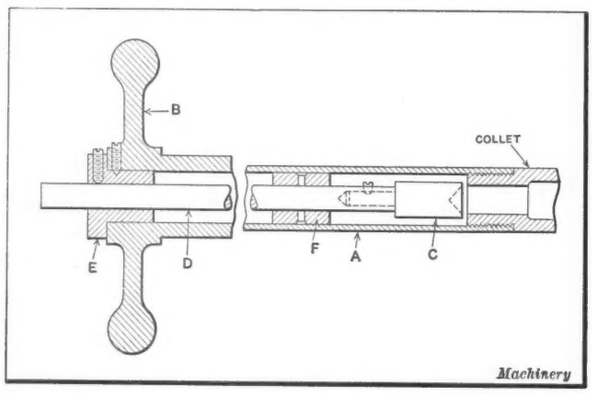
RECOVERY OF BELGIAN IRON AND STEEL INDUSTRIES

Belgium is gradually rehabilitating her industries, although the progress naturally is slow. In the early part of this year, the pig iron production of Belgium amounted to about 20 per cent of the pre-war production, and the steel production to about 27 per cent of the production in 1913. The wrought-iron production in January, 1920, was over 26,000 tons, which was slightly greater then the average monthly production in 1913, indicating that in this field Belgian mills have entirely recovered their pre-war production capacity. The coal production has also regained the average total previous to the war and in certain districts is now exceeding the output in 1913. In some districts, where the damage to mines was the greatest, the production is still below the pre-war figures, but not more than an average of about 15 per cent.

SHOP AND DRAFTING-ROOM KINKS

STOP FOR DRAW-IN COLLET CHUCK

A device for regulating the depth to which work is to be inserted in a draw-in collet chuck is shown in the illustration. The stopping attachment is contained in tube *A*, which



Attachment for regulating the Distance the Work should extend into the Collet

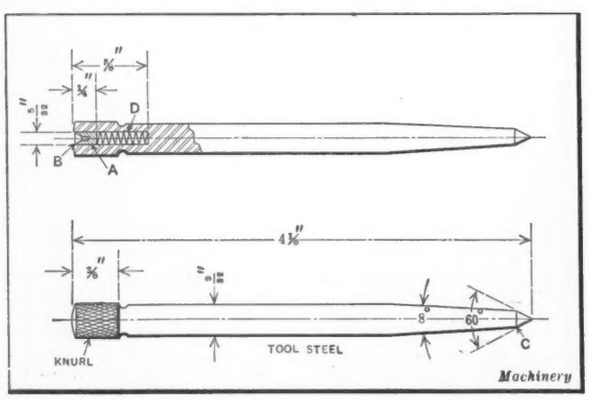
connects handwheel *B* with the shank of the collet, and by means of which the collet is operated in or out when the handwheel is revolved. On a machine equipped with this attachment, the work is inserted in the collet until it comes in contact with the front end of stop *C*. The stop-bar *D*, to which the shank of stop *C* is secured by means of a headless set-screw, is a sliding fit in bushing *E*. This permits the bar to be readily adjusted to the proper longitudinal position to suit the desired length of the work. The bar is secured in position by means of a set-screw provided in the bushing for the purpose. The collar *F*, which is pinned to bar *D* and is a sliding fit in tube *A*, supports the forward end of the bar.

When it is desired to use this stop for gaging the length of short work, stop *C* should be designed to project sufficiently into the shank of the collet. Machining the front end of the stop to suit, when the end of the work is not flat, often gives better results than are obtained otherwise.

Paterson, N. J. STEPHEN COURTER

LATHE CENTER WIGGLER

The accompanying illustration shows the construction of a center wiggler which has been used satisfactorily for truing up work in a lathe. After the work has been properly



Wiggler used to true up Work held in Lathe Chuck or on Faceplate

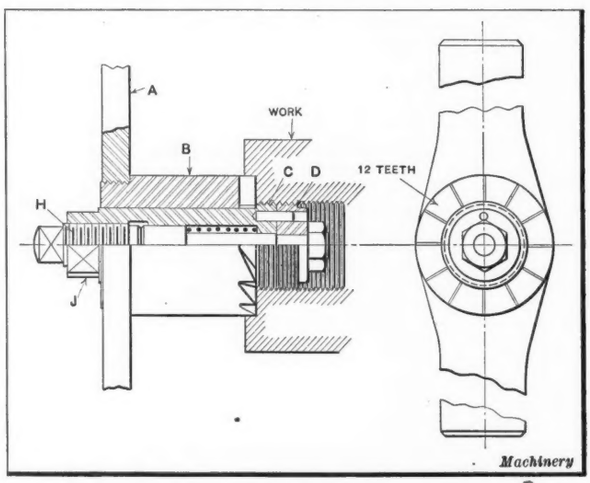
spotted, either by means of a milling machine or some other accurate method, it is set up on the lathe and the wiggler set with the pointed end in the spot on the work. The tail-center of the lathe is located in the opposite end of the wiggler. The spring arrangement for the female center will keep the pointer from distorting the spot in the work before it is properly trued up. By using an indicator at the pointer end of the wiggler and tapping the work until no deflection in the indicator pointer is noted, the work will be accurately located.

The tool consists of a tool-steel spindle with a knurled head and a 60-degree point *C*, which is hardened on one end and ground. The knurled end of the tool is drilled out as shown and carries a coil spring *D* and a hardened steel center *A*. The edges of the hole in which center *A* is fitted are rolled as shown at *B* in order to hold the parts together. All necessary dimensions for making this tool are given on the illustration.

Bridgeport, Conn. GUSTAVE BAHR

HAND FACING TOOL

The accompanying illustration shows a hand facing tool that was designed to finish the surface surrounding a tapped hole. Many counterbored holes are encountered on airplane



Hand Tool for counterboring Tapped Holes

and automobile engine work, and on the Hispano-Suiza airplane engine, in particular, considerable trouble was experienced in making the counterbored surface square with the center of the tapped hole. The tool here shown is screwed into the work to the required depth by means of the hexagonal head *J* on the center plug *C*. Then by turning the screw plug *H*, a tension is produced between the two screw plugs *C* and *D*, which causes them to bind against the opposed flanks of the threads in the hole so that they become locked in place. By this means the tool is held firmly and the face of the high-speed steel mill *B* is held perpendicular to the center line of the hole. By manually turning the handle *A*, the facing mill, which is independent of the rest of the tool, will face or counterbore the hole to the required depth as determined by the depth to which the plugs were originally screwed in. This provides a stop for the counterbore and assures accurate results. This tool has been extensively used on this type of work.

Irvington, N. J. C. H. DENGLER

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

FORCE REQUIRED FOR BENDING BARS AND PLATES

P. M.—It is sometimes necessary to know approximately, at least, how much pressure will be required to bend a bar or plate. Is there any simple way of determining the required pressure?

A.—In the design of most machines and structures, bending stresses are to be resisted, but occasionally it is necessary to determine approximately the force that will actually bend a bar or beam. Ordinary beam formulas may be used, whether the beam is to bend or to resist bending. When it must resist bending, the stress on the extreme or outer fibers of the beam (where the stress is greatest) must be less than the elastic limit of the material. In fact, the fiber stress should be considerably less than the elastic limit in order to avoid excessive deflection of the beam and to make it safe. On the contrary, when a bar or plate is to be bent, the applied force must be great enough to overcome the elastic limit of the material. Hence, in the following rules and formulas for determining the force required for bending, a value is employed which is assumed to be equal to, or slightly greater than, the elastic limit of the material. The elastic limit of steel is generally assumed to be one-half the ultimate tensile strength, although it might be two-thirds of the ultimate strength in the case of nickel steel and heat-treated forgings. It is evident, then, that the force required for bending, as determined by calculations is only approximate.

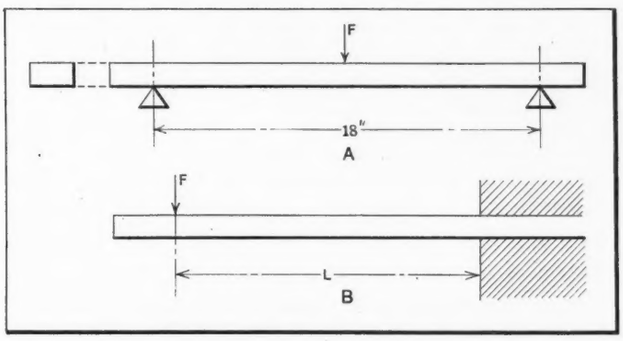


Diagram illustrating Calculation of Force required to bend Bars and Plates

The method of calculating force required for bending depends upon the way the bar or plate to be bent is supported, and how the force is applied. Ordinarily, the parts to be bent are either supported at both ends and the force is applied in the center, or the work is held rigidly at one end and the force or pressure is applied at the other. To illustrate the first case mentioned, suppose a structural steel bar ¾ inch thick and 1½ inches wide is supported at points 18 inches apart as shown at *A* in the illustration. If the force *F* is applied at a point midway between the supports, how many pounds pressure will be required for bending the bar?

The tensile strength of structural steel is about 60,000 pounds per square inch, and if the elastic limit is assumed to be 35,000 pounds per square inch, this will doubtless be somewhat greater than the actual elastic limit. The load in pounds required for bending may be determined as follows:

Rule—Multiply the square of the thickness of the bar (vertical dimension) by twice its width in inches, and multiply the product by the value assumed for the elastic limit. Then divide this product by three times the distance in inches between the supports.

Applying this rule to the example given, the square of the thickness, or 0.75, equals 0.5625, and $0.5625 \times 1.5 \times 2 = 1.6875$. The assumed value for the elastic limit, or $35{,}000 \times 1.6875 = 59{,}062$. Dividing by three times the distance between the supports we have $59{,}062 \div 3 \times 18 = 1093$ pounds. This is, of course, only approximate. The actual load required for bending would probably be a little less than the calculated load, especially if the value assumed for the elastic limit were somewhat greater than the actual elastic limit. If the foregoing rule is expressed as a formula in which

F = force in pounds required for bending;
S = stress in pounds per square inch, which exceeds somewhat the elastic limit of the material;
B = width of bar in inches;
T = thickness of bar in inches, or its vertical dimension;
L = distance between supports in inches.

Then

$$F = \frac{S \times 2 \times B \times T^2}{3L}$$

When the bar or plate to be bent is held at one end and the force is applied at the other, the pressure in pounds required for bending may be found as follows:

Rule—Multiply the square of the thickness of the material (vertical dimension) by its width in inches, and the product by the value assumed for the elastic limit. Divide the product thus obtained by six times the distance in inches from the point where the pressure is applied to the point where the bend will occur. (Equals distance L of diagram *B*.) The result will equal the required force in pounds.

Example—A steel plate ½ inch thick and 6 inches wide is to be bent, and the force is to be applied 13½ inches from the clamping jaws or from the center of the bend. It is assumed that the elastic limit is 35,000 pounds per square inch and that the plate to be bent is held rigidly on each side of the place where the bend is required, as shown at *B*.

The square of the thickness equals 0.5^2 or 0.25. Multiplying by the width of the plate, $0.25 \times 6 = 1.5$ and $1.5 \times 35{,}000 = 52{,}500$. Dividing by six times the distance L, we have $52{,}500 \div 81 = 650$ pounds nearly. If

F = force in pounds required for bending;
T = thickness of plate in inches, or its vertical dimension;
B = width of plate in inches;
L = distance between point where pressure is applied and center of bend;
S = stress in pounds per square inch, which slightly exceeds elastic limit of material;

$$F = \frac{S \times B \times T^2}{6L}$$

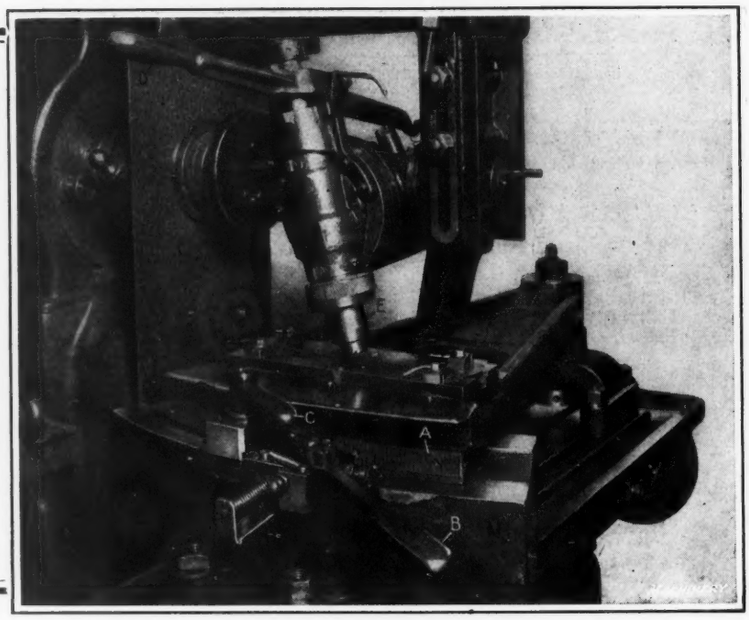
The values of S will vary considerably for different grades of steel, and also with the condition of the steel. For instance, unannealed steel will have a higher elastic limit than annealed steel. Consequently, the force required for bending can be calculated only approximately.

* * *

The Wisconsin Circuit Court has handed down a decision overruling a former decision of the State Industrial Commission. The Circuit Court's decision declares that the stockholders and officers of a company when performing duties as employes are not debarred from compensation for injuries received during such employment, but are entitled to it under the Workmen's Compensation Act. It is specifically stated that "no one can be denied compensation merely because he is an officer of an employing corporation, if in fact he performs duties of an employe as distinguished from those of an officer."

Cutting Teeth of Special Rack for Sight Mechanism

By CHARLES HARDY
General Manager
Blair Tool & Machine Works, New York City



WHEN the United States entered the world war, it was necessary to solve many mechanical problems in connection with the manufacture of guns, airplanes, and munitions of various kinds. The War Department decided to make about 1000 of the popular 75-millimeter "American" gun carriages. As government arsenals were able to produce but a small part of the tremendous output of munitions required, the Government turned to private manufacturers. The order for gun carriages was divided among several manufacturers, and many of the intricate parts were handled as separate items and given to different concerns in order to insure deliveries being made as soon as possible.

One of the parts of the sight mechanism which is interesting as a manufacturing problem is known as the rocker-arm rack. This part is shown in Fig. 1. When the sight mechanism is assembled, a spiral scroll gear meshes with this rack, and the adjustment for sighting the gun is obtained as the scroll gear is revolved. The axis of the scroll gear is inclined at an angle of 14½ degrees, so that the rack is in mesh with one side of the scroll.

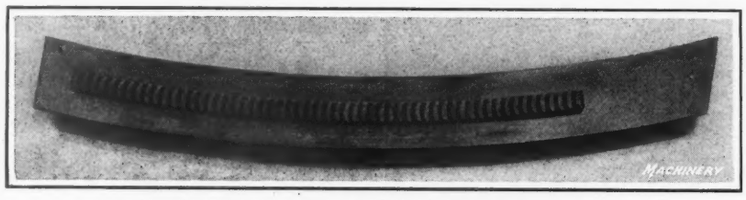


Fig. 1. Rocker-arm Rack of Sight Mechanism

An enlarged detail view of the rack and teeth is shown in Fig. 3. The teeth are inclined at an angle of 14½ degrees, and the upper sides have a smaller radius than the lower sides, as the illustration shows. These two radii are necessary in order to avoid interference, because the teeth come into mesh with varying curvatures as the spiral scroll is revolved. It will also be noted that the centers of the tooth arcs are offset relative to the center line of the arc, which is necessary in order to secure a free movement without interference. As backlash or lost motion was limited to 0.0005 inch, it was necessary to provide accurate means for doing the work.

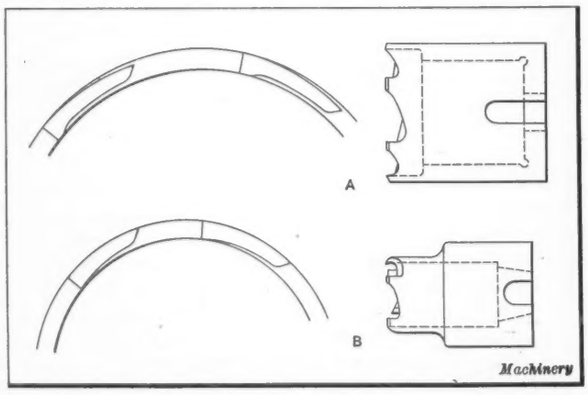


Fig. 2. Special Cutters used for Rocker-arm Racks—Enlarged Views of Cutter Teeth at Left

The special work-holding and milling fixture used is shown in the heading illustration. The radius to the center line of the rack is 21 inches, and the work-holder is provided with a slot conforming to its radius, the rack being clamped in the slot. The work-holder is pivoted at one end, the distance from the axis of the pivot to the center line of the rack being equal to the required radius of 21 inches. Another rack *A* forming part of the fixture is attached to the work-holder and serves to space the teeth on the work the required distance apart. The lever *B* is used for indexing from one tooth or division to the next. When a tooth is being milled, the work-holder is rigidly clamped to its base by lever *C*.

The special cutters used for this work are shown in Fig. 2. That side of the tooth having the larger radius is formed by the outside of cutter *A*, whereas the other side is formed by the inside of the smaller cutter *B*. As the teeth of the rack are inclined at an angle of 14½ degrees, the elevating screw of the milling machine could not be used for vertical feeding, it being necessary to feed the cutter-spindle in line with its axis when set at the required angle. For this reason the milling attachment was provided with a sliding spindle which is operated by hand-lever *D*, shown in the heading illustration.

After milling the side of the tooth having the larger radius, the smaller cutter was inserted in the special holder provided and the entire table of the machine was moved 0.026 inch (see Fig. 3) as this is the distance between the center lines on which the centers of the large and small tooth arcs are located. The shell-shaped cutters are held in the socket of a special holder *E* (see the heading illustration) which enables them to be removed easily when one cutter is replaced by the other.

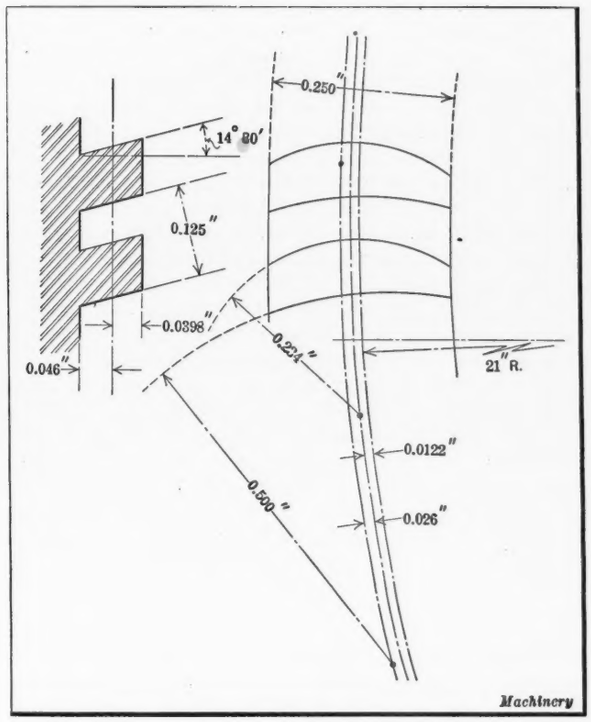


Fig. 3. Enlarged View of Rack Teeth

COMMERCIAL AERIAL TRANSPORTATION

Few people realize that regular aerial passenger service is an established fact. We know that mails are being carried regularly between various points in this country, and the newspapers have frequently referred to the airplane service between various cities in Europe, but that regular passenger service is maintained between London and Paris is not so generally known. Beginning August 25, 1919, one French and one British company inaugurated daily trips by airplane between the two capitals. Since that time, two additional French companies and one other English concern have established similar services. The distance is about 250 miles, and the trip takes from two to three hours. The best time that has been made is slightly less than two hours. The trips are taken in the early afternoon. At the present rate of exchange, from $40 to $50 is charged for a trip, and excess baggage costs about 30 cents a pound. In the first nine months of the service, 1074 trips were made and 1641 passengers carried, in addition to about 80,000 pounds of merchandise and over 1000 sacks of mail. The airplane method of crossing the channel appears to be growing in favor, as five times as many passengers were carried in May, 1920, as in the earlier months of the service. Most of the airplanes in service have accommodations for from two to four passengers, but some have large cabins with room for as many as a dozen people.

* * *

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building, 29 W. 39th St., New York City, December 7 to 10. Among the sessions, one will be included on the subject of Appraisal and Valuation, and another on the Application of Engineering to Woodworking. The newly founded professional sections on Management, Power, Fuels, Machine Shop Practice, Railroads, and Textiles will have separate sessions to consider the vital problems in their respective fields. In addition, there will be a number of papers of value and interest to engineers presented at the general sessions. A memorial session for Dr. Brashear is planned as a fitting tribute to the life and work of a great engineer.

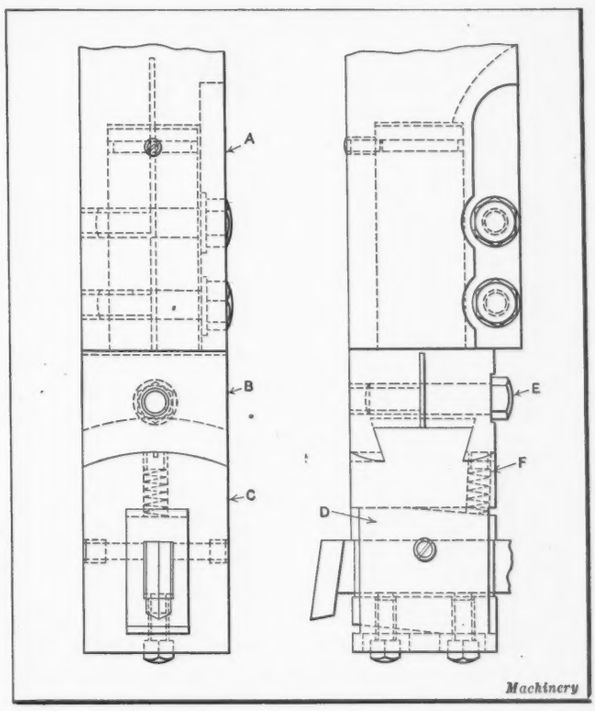
SLOTTING MACHINE TOOL-HOLDER

By HENRY DAUT

The accompanying illustration shows a tool-holder for a slotting machine, which is of such construction that the tool can be set in any angular position in a horizontal plane and can also be tilted with respect to a vertical plane. A click-box feature is incorporated to prevent the tool from scraping heavily against the work on the return stroke of the ram of the machine. The cast-iron holder *A* is attached to the lower end of the ram and can be made of any desired length. Part *B* is provided with a cylindrical shank, which is clamped in holder *A* by means of two machine screws. The setting of the tool in any position in a horizontal plane is accomplished by turning part *B* to the desired position, and then clamping it in place. This feature eliminates the necessity of changing the position of work on the machine table. A small headless set-screw in holder *A* engages a groove around the upper end of the shank of part *B* and prevents the shank from falling out of the holder when the clamping screws are loosened.

Part *C*, which contains the click-box, is provided with a circular dovetail tongue, by means of which the part is held in a corresponding groove in part *B*. As the tongue and groove are circular, part *C* and the tool can be tilted in various positions with respect to the vertical axis. A slot is cut across part *B* so that this part can be drawn slightly together by screw *E*, in order to clamp part *C* in position. Parts *B* and *C* are both round and made of machine steel. The click-box *D* is made of tool steel, and is spring tempered. It is machined on the top at the rear and on the bottom at the front to permit the tool to be tilted away from the work on the return stroke of the ram. It is important that the opposite sides of the surfaces mentioned are a close fit against the top and bottom of the slot in part *C* when a cut is being taken on the work. The pins on which the click-box is pivoted must also be located true to obtain a smooth working action.

The coil spring *F* is placed in a hole in part *C* and exerts a sufficient pressure against the click-box to place the tool in the cutting position before it reaches the work on the downward stroke. The pressure of this spring, however, is overcome as the tool bears against the work on the return stroke, so that the tool is tilted away from the work.



Tool-holder which permits Tool to be set in Any Horizontal Position and tilted from the Perpendicular

MILLING A SPLINED SHAFT

By J. B. GRAY

Frequently when there is a lack of proper shop equipment for the performance of a certain operation, the ingenuity of the foreman or machine operator is relied upon for finding some means by which the work can be satisfactorily accomplished with the use of existing equipment. Such was the case when the writer was called upon to mill ten spline grooves on the end of shafts 42 inches in length on a milling machine having a table so short that the work could not be held between index centers. The tolerances allowed on the spline dimensions were very small, as will be seen by referring to Fig. 1, which gives a sectional view of the splined portion of the shaft and the corresponding dimensions. The splines were to be finished by grinding in a later operation, and while the tops of splines in a job like this can be readily ground to the proper size, the grinding of the sides is always a slow and expensive operation. For this reason the grinding allowance on these surfaces was only 0.002 inch, and thus accurate spacing of the grooves was required.

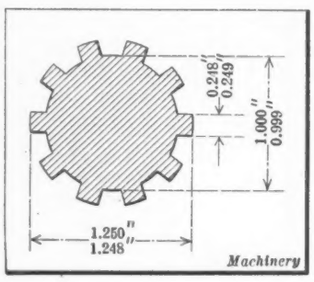


Fig. 1. Sectional View of Splined Portion of Shaft

The set-up that was finally employed on the milling machine for the operation is shown diagrammatically in Fig. 2. From this illustration it will be seen that the end of the shaft on which the grooves were to be machined was supported in an indexing head *A* and that the remainder of the shaft was supported near the middle by means of a lathe steadyrest *B*. This steadyrest also furnished a means of clamping the work in position after it had been properly indexed by the use of the indexing head. It was necessary to block up the indexing head several inches to place the center in proper alignment with the jaws of the steadyrest.

After the indexing head had been mounted on the machine table, the jaws of the steadyrest were adjusted radially to the proper position through the use of an aligning bar and an indicator attached to the end of a surface gage. The aligning bar was placed on the center of the indexing head and extended through the jaws of the steadyrest, being of the same diameter as the section of the shaft which was to be supported between the jaws. The amount of adjustment which the jaws required was readily observed by means of the indicator. After the aligning bar had been removed, the screw which operates jaw *C* was advanced one or two turns, the position of the two remaining jaws being undisturbed, so that when work was later placed in the steadyrest it was tightly clamped on account of the advanced position of jaw *C*. The upper part of the steadyrest was then swung back to permit the work to be placed in position.

After a dog had been attached to the front end of the shaft so that the work would be revolved with the center of the indexing head, the work was placed on the center and the steadyrest. The hinged part of the steadyrest was then placed in a closed position but was not clamped to the lower member. The index crank was next turned sufficiently to take up all backlash and to bring the plunger to a convenient position, after which jaw *C* was clamped on the work by tightening nut *D*, which is used to hold the upper member of the steadyrest in a closed position on the lower member. The dog was then loosened and removed to the position indicated at *E*, and the first groove was cut on the work by means of a slitting saw, ⅛ inch wide.

After the first cut had been taken across the work, the table was returned to its starting position, the dog carefully replaced, nut *D* loosened, and the work indexed the proper amount. Nut *D* was then retightened, the dog removed as previously described, and a cut taken on the next groove. The same procedure was followed in indexing the work for milling the remaining eight grooves. After each groove had been machined by the slitting saw, the splines were finished by straddle-milling, the proper spacing being again obtained by the method outlined in the foregoing.

* * *

NINTH SAFETY CONGRESS

The ninth annual congress of the National Safety Council will be held in Milwaukee September 27 to October 1. There will be four general sessions and sixty-two sectional meetings of which sixteen will be industrial sections on health service, education, and safety in the engineering trades. There will be a great many addresses by men prominent in the industrial and transportation fields in managing and executive capacities, as well as papers read by men who have made safety engineering their life work. A program especially fitted to the needs of men who are beginning work in the accident prevention field has been planned for the general session beginning at 10 o'clock Tuesday morning, September 28. In conjunction with the convention, there will be an exhibition of safety appliances at the Milwaukee auditorium. This safety exhibit promises to be the biggest yet held by the National Safety Council. Applications for space should be addressed to W. H. Frater, business manager, 168 N. Michigan Ave., Chicago, Ill.

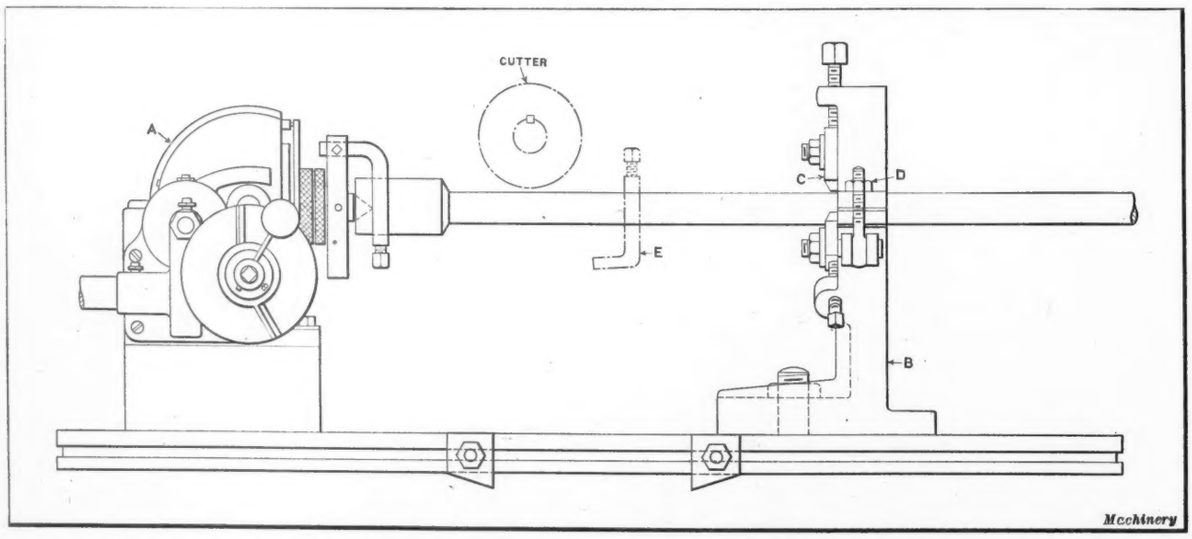


Fig. 2. Set-up employed for milling Spline Grooves on Shafts of a Length that prevented the Use of Index Centers

True Stresses in Rectangular Steel Bars

By N. BARNES HUNT, Engineer, United States Reclamation Service, St. Ignatius, Montana

THE following presentation of combined stresses is supplementary to the article entitled "Practical Applications of the Combined Stress Theory," which was published in the August, 1919, number of MACHINERY, and is subject throughout to the same general conditions and limitations. It may be of interest in comparison with the formulas for combined stresses deduced by Victor M. Summa in an article entitled "Combined Stresses" published in the July number of the same year. In that discussion Mr. Summa used the apparent stress theory, or a combination of stresses by the methods of statics, while the theory here employed is known as the true stress theory, in which stress is assumed to be a function of deformation.

A single force will cause deformation in two perpendicular directions, the amount of deformation occurring laterally with respect to the direction of the load being given by Poisson's ratio. The stresses resulting from the application of this theory are called true stresses. Further complications are introduced by a consideration of two forces applied at right angles to each other. This discussion is limited to such a condition, in which the applied forces produce flexural and torsional stresses. For the purpose of enabling the discussion to be more clearly followed, the general formulas for true stresses as deduced by Merriman, which apply when the axial force is tension, will be repeated here:

$$S_t = \tfrac{1}{2}\,(1 - R)\,S_{ts} + (1 + R)\,\sqrt{S_{ss}^2 + (\tfrac{1}{2}\,S_{ts})^2} \qquad (1)$$

$$S_s = (1 + R)\,\sqrt{S_{ss}^2 + (\tfrac{1}{2}\,S_{ts})^2} \qquad (2)$$

in which

S_t = true unit tensile stress;
S_s = true unit shearing stress;
S_{ts} = simple unit tensile stress;
S_{ss} = simple unit shearing stress;
R = Poisson's ratio.

Formulas for tension and shear may be developed from Formulas (1) and (2) by substituting in them the values of S_{ts} and S_{ss} found from the flexure and torsion formulas, respectively, and using a suitable factor of lateral contraction, which is usually taken as one-third for steel. Assuming that the load causing flexure acts in the same direction at all times, the neutral axis will occupy an infinite number of positions with respect to a rotating shaft, and the value of the rectangular section modulus will be variable, from which it is evident that S_{ts} will also vary. In the following equations,

M_b = bending moment in inch-pounds;
d = breadth of cross-section in inches;
l = length of cross-section in inches.

When the neutral axis is parallel to d:

$$S_{ts} = \frac{6M_b}{dl^2} \qquad (3)$$

When the neutral axis is parallel to l:

$$S_{ts} = \frac{6M_b}{d^2l} \qquad (4)$$

When the neutral axis coincides with a diagonal:

$$S_{ts} = \frac{6M_b\sqrt{d^2 + l^2}}{d^2l^2} \qquad (5)$$

In the last case, the maximum stress is attained, but since this stress occurs at a corner of the bar and since the torsional stress is zero at the corners, no combined effect need be considered. The bar occupies its most critical position when the flexural load acts in a direction perpendicular to the length of the cross-section; consequently Formula (4) should be used for revolving shafts or bars. The appropriate formula for use when bars are in static equilibrium depends upon the direction in which the load is applied.

The formula for finding the torsional stress at the middle of the short side d, is

$$S_{ss} = \frac{9M_t}{2dl^2} \qquad (6)$$

and at the middle of the long side l,

$$S_{ss} = \frac{9M_t}{2d^2l} \qquad (7)$$

in which M_t = the torsional moment in inch-pounds.

Formula (7) gives the maximum torsional stress in the bar. Assuming $R = 1/3$ and substituting values from Equations (3) and (6), Formulas (1) and (2) may be written

$$dl^2 = \frac{2M_b + 2\sqrt{9M_t^2 + 4M_b^2}}{S_t} \qquad (8)$$

$$dl^2 = \frac{2}{S_s}\sqrt{9M_t^2 + 4M_b^2} \qquad (9)$$

when the flexural load acts in a direction perpendicular to the breadth d of the bar section. In like manner, using values taken from Equations (4) and (7), Formulas (1) and (2) may be written

$$d^2l = \frac{2M_b + 2\sqrt{9M_t^2 + 4M_b^2}}{S_t} \qquad (10)$$

$$d^2l = \frac{2}{S_s}\sqrt{9M_t^2 + 4M_b^2} \qquad (11)$$

when the flexural load acts in a direction perpendicular to the length l of the section.

When the bar is of square section, $d = l$, and these formulas may then be written

$$d^3 = \frac{2M_b + 2\sqrt{9M_t^2 + 4M_b^2}}{S_t} \qquad (12)$$

$$d^3 = \frac{2}{S_s}\sqrt{9M_t^2 + 4M_b^2} \qquad (13)$$

for a flexural load acting in a direction perpendicular to any side.

In each of the preceding groups of two formulas, the size of the bar is governed by the greater value of dl^2, d^2l, or d^3.

The flexural compressive stress has been ignored in these deductions, but it may be used instead of the tensile stress when the strength of the material is approximately the same in tension and compression, by substituting the simple unit compressive and shearing stress values in the basic formulas (1) and (2). Since the simple tensile and compressive stresses are equal, when both are flexural stresses, the only change in the formulas will be the substitution of the true unit compressive stress values for the true unit tensile stress values.

Example—The first example used in Mr. Summa's article published in MACHINERY for July, 1919, which has previously been referred to as exemplifying the apparent stress theory, may also be employed in this case. The problem is to find the size of a square-sectioned bar, subjected to a bending moment of 100,000 inch-pounds, and a torsional moment of 80,000 inch-pounds, allowing a working stress of 12,000 pounds per square inch in tension and 9600 pounds per square inch in shear. It is assumed in the following solution that the material is steel.

From Formula (12) for bars of square section,

$$d^3 = \frac{2 \times 100{,}000 + 2\sqrt{9\ (80{,}000)^2 + 4\ (100{,}000)^2}}{12{,}000} = 68.73$$

$d = 4.10$ inches

and from Formula (13)

$$d^3 = \frac{2}{9600}\ \sqrt{9\ (80{,}000)^2 + 4\ (100{,}000)^2} = 65.09$$

$d = 4.02$ inches

The corresponding values obtained in the article referred to were 4 inches, and 3.66 inches respectively, from which it is seen that only in the value obtained by using the shearing stress S_s, is there an appreciable difference. It does not follow, however, that the two theories will always agree so closely. In general, the use of the true stress theory will result in larger sections than found by the apparent stress theory. There is some difference of opinion as to whether this increase in the size is justified, and the difference may, of course, be neutralized within certain limits by using a different factor of safety. The designer may form his own opinions after consulting the leading authorities.

* * *

NOTES FROM THE AMERICAN INSTITUTE OF WEIGHTS AND MEASURES

The American Institute of Weights and Measures, 115 Broadway, New York City, in a recent statement, points to the practically universal use of the English system of measurements in the lumber trade, even in countries that otherwise use the metric system. Quoting from the U. S. Commerce reports of February 11, 1920, it is stated that, according to trade commissioner A. X. Oxholm, lumber exported by one of the saw-mill companies in northern Sweden is cut as follows: 69 per cent to English measurements; 7 per cent to Danish feet; 7 per cent to Spanish feet; 4 per cent to Dutch feet; 4 per cent to German feet; and 9 per cent to the metric system. Of the 9 per cent, however, 8 per cent is cut to what is known as "metric feet," the metric foot being one-third of a meter, a sub-division of the meter that equals about 9 per cent more than an English foot.

It is further pointed out that the overwhelming proportions of British and American foreign and domestic trade has secured for the English system of measurements a universality in the engineering trade, due to natural processes, which no amount of compulsory legislation could have made possible. Thus, 70 per cent of the world's output in steel is manufactured in the United States and Great Britain to the English system of measurements, and these two countries are also responsible for approximately two-thirds of the world's production of machine tools and 80 per cent of the world's production of screw products. The United States alone manufactures 90 per cent of the world's motor vehicles. Generally speaking, two-thirds of the commerce of the world is in manufactured products produced on the basis of the English system of weights and measures.

* * *

MATERIALS HANDLING SECTION OF A. S. M. E.

The Materials Handling Section of the American Society of Mechanical Engineers met at the Engineering Societies' Building, 29 W. 39th St., August 13, to consider ways and means for promoting the art of the mechanical handling of materials. Robert M. Gates of the Lakewood Engineering Co. presided and addresses were made by a number of other engineers well known in the material-handling field. It is intended that the section, which has recently been formed, shall be a channel of intercourse between technical and industrial organizations on the subject of mechanical handling of materials. The section shows great activity, and 381 members signed the petition to the council of the American Society of Mechanical Engineers, requesting the formation of such a section.

USE OF TITANIUM IN STEEL

In view of the constant investigations as to the value of various metals in alloy steels, the following review of the present status of titanium as an alloying metal, published in a recent number of *Reactions*, is of interest. It is stated that while vanadium is comparatively scarce, there are large quantities of high-grade titanium ores in the United States, sufficient to last over one hundred years. A great amount of research work is now being applied to titanium, the use of which as a content in steel has hitherto been comparatively unknown. Until recently ferro-titanium was known simply as a deoxidizer.

During the war, France used a great deal of titanium, not only as a deoxidizer, but also in the production of steel having a certain content of titanium. It has also been learned that some of the other European countries, particularly Germany and Sweden, are using titanium as a content in the production of automobile and other steels which are subjected to most severe service. Such steel has been a successful competitor of American steels of about the same composition but without titanium. American steel makers, however, have since experimented along the same lines, with the result that they are now producing a steel which is at least equal to that of their European competitors.

Research work has not stopped here, but has been extended into the tool steel industry, and the results of experiments indicate that titanium can be used to advantage in place of all or part of some other alloy materials. This is of particular interest to American manufacturers of high-grade steels, who have been unable always to obtain ferro-vanadium in sufficient quantities and have been forced to look for substitutes. Alloy steel makers who have been experimenting with titanium as a substitute report satisfactory results, and think it is only a question of time until the public is educated to the merits of such steel. An argument for the close study of the possibilities of titanium is the fact that there are unlimited supplies of high-grade titanium in this country. Also, the price of titanium ores is very low in comparison with that of ores of the other well-known alloying metals.

* * *

ORGANIZATION PROGRESS OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES

The Joint Conference Committee of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, acting as a committee in accordance with the authorization of the Organizing Conference held in Washington, D. C., June 3 and 4, 1920, has extended an invitation to the engineering and allied technical organizations in the country, to become charter members of the American Federated Engineering Societies, and to appoint delegates to the first meeting of the American Engineering Council to be held in November. At the meeting in Washington, 140 delegates were present, representing 71 engineering and allied technical organizations. It was the unanimous opinion of the conference that there should be created an organization "to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern in the engineering and allied technical professions," and that this organization should consist of societies or affiliations, and not of individual members. On the basis of these fundamentals, a constitution and by-laws were adopted.

The Joint Conference Committee has asked each organization invited to take favorable action in the matter of membership in the organization at the earliest possible moment and to advise the committee promptly of the names of the delegates who will attend the first meeting of the American Engineering Council in November of this year. The address of the committee is 29 W. 39th St., New York City.

Machine for Testing Efficiency of Spur Gears

A MACHINE for testing the efficiency of spur gear drives has recently been developed by the National Physical Laboratory of Great Britain. In this machine, as described by T. E. Stanton in *Engineering*, the two gears being tested are mounted on shafts, and the machine measures the torque of the driving shaft and the difference between the torques of the driving and driven shafts. After the torques on both gear shafts are known, the efficiency of the gears can readily be determined by dividing the torque of the driving shaft by that of the driven shaft. The machine is of one-horsepower capacity, it having been thought preferable to build a small machine for experimental purposes before attempting to build a larger one for practical use. By referring to the accompanying illustrations an idea of the construction of the machine may be obtained.

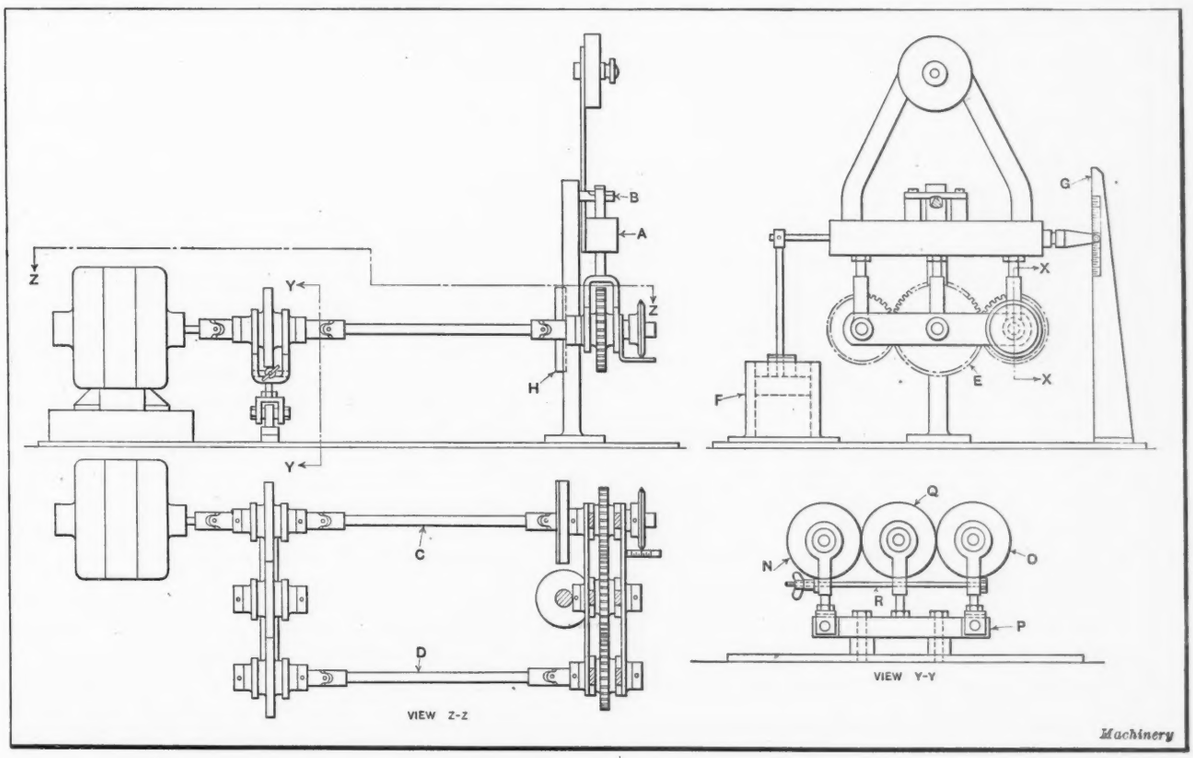


Fig. 1. Machine developed by the National Physical Laboratory of Great Britain for determining the Torques of the Shafts on which the Gears under Test are mounted

The frame *A*, Fig. 1, on which the gears being tested are mounted, is entirely supported by a horizontal knife-edge *B*. It will be noticed that driving shaft *C* and driven shaft *D* are provided with universal joints on each end. By this arrangement it is possible for frame *A* to oscillate somewhat in a vertical plane about its neutral position. An intermediate wheel *E* is placed between the gears being tested, because it is necessary for both shafts to rotate in the same direction in order for the reaction on the frame to be equal to the difference between the torques on the driving and driven shafts. If they should revolve in opposite directions the reaction would be equal to the sum of the torques. An oil dashpot *F* is provided for damping the oscillations of frame *A*, and a scale pan in the dashpot and scale *G* are furnished for measuring the difference between the torques of the two shafts.

There is an indicator on the driving shaft for determining the torque of this shaft. The construction of this indicator may be observed by referring to Fig. 2. Motion is transmitted from driving shaft *C* to one of the gears being tested, by means of two spiral coil springs *I* and *J*, which rotate box *H*. These springs are of equal dimensions, one of them being left-hand while the other is right-hand. Box *H* has a long sleeve on which the gear is mounted and through which shaft *C* extends. The shaft has a double spiral groove of 2 inches pitch on its right-hand end, this end being a sliding fit in the sleeve of box *H* on which the torque indicator *K* is also mounted. The sleeve has two longitudinal slots in it in which two studs *L*, which are attached to the torque indicator, slide. The inner ends of these studs are provided with hardened steel rollers which project into the spiral grooves. It is obvious that the relative motion of the spiral groove on the driving shaft and the sleeve on which the gear is mounted will cause an axial movement of the torque indicator, and that if a calibrated scale is provided, the value of the torque can be read on this scale. Scale *M* is provided for this purpose.

By referring to the view *Y–Y* in Fig. 1, it will be apparent that the power from the driven shaft is returned to the driving shaft by means of a friction drive. The two outer wheels *N* and *O* are made of cast iron and have a velocity ratio about 5 per cent greater than that of the gears under test. These wheels are supported by rocking arms which permit a freedom of movement in a vertical plane about pin connections in the supporting bracket *P*. The intermediate wheel *Q* is made of red fiber and is supported by a bearing which is fixed to bracket *P*. The hinged bearings are connected by a steel rod *R* which passes through their forks. The tension in this rod can be adjusted by means of the wing-nut at the left end, the elasticity of the connection being supplied by means of a beam spring across the forks of the bearing at the right end. By varying the tension in this rod, the power passing through the gearing can be

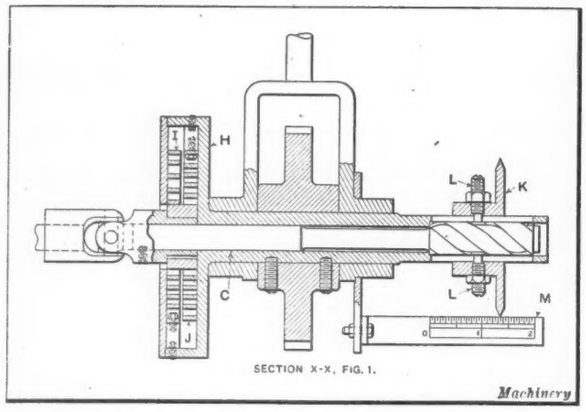


Fig. 2. Sectional View showing Torque Indicating Device on Driving Shaft

varied over a fairly wide range, the upper limit of which depends upon the frictional resistance of the fiber wheel.

In making a test, the most convenient method is to place weights in the scale pan corresponding to a given torque difference and then regulate the tension in rod *R* by means of the wing-nut until the frame is balanced with the pointer indicating the zero graduation on the torque difference scale *G*. A reading of the torque indicator *K*, Fig. 2, will then give all the data necessary for the determination of the gearing efficiency. In an experiment on two gears having 60 teeth of 14 diametral pitch revolving at 1230 revolutions per minute, with which an intermediate gear having 75 teeth was used, the measured torque of the driving shaft was 4.28 foot-pounds and the difference between the torques of the driving and driven shafts was 0.88 foot-pound. The torque of the driven shaft was therefore equal to 4.28 — 0.88 or 3.40 foot-pounds. Therefore the combined efficiency of the three gears was equal to 3.40 ÷ 4.28 or about 79 per cent. And the efficiency of transmission of each pair of gears was approximately 89 per cent. A modification of the machine described in the foregoing is now being developed for use in testing bevel gears and chain drives.

* * *

TAPPING ATTACHMENT WITH AUTOMATIC REVERSAL

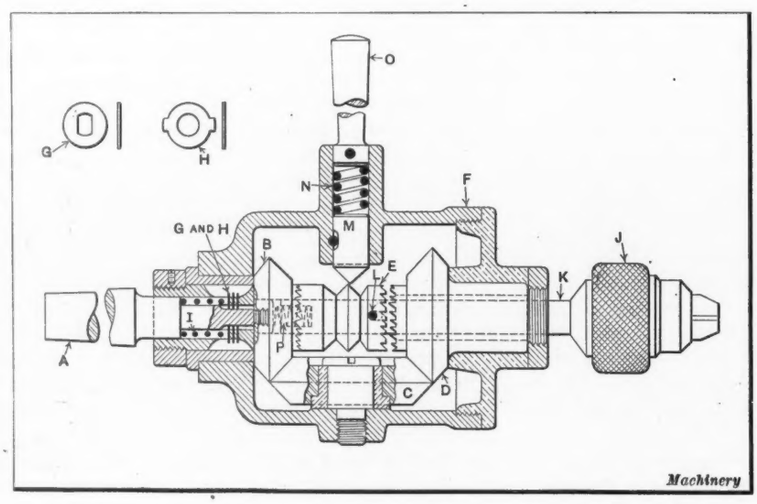
By CHARLES RUIZ

Reversal of the direction in which the tap rotates is automatically obtained when the tapping of a hole is completed, through the use of the attachment illustrated, without necessitating a change in the direction in which the driving spindle of the machine rotates. This device was designed for use on a special chucking machine, but it is also applicable to lathes, drilling machines, and other machines built along the same lines. The fact that the attachment reverses itself makes it especially convenient for use in tapping deep holes. In such cases, the operator can tend to several machines, because after the tapping of a hole has commenced, no attention is required until the operation has been completed and the tap withdrawn.

The attachment is driven by means of shank *A*, which is inserted in the socket in the end of the machine spindle. The rotation of the spindle in the two directions necessary to feed the tap into the hole and effect its withdrawal is secured through the three bevel gears *B*, *C*, and *D* and clutch *E*, these parts being contained in the cylindrical housing *F*. Gear *B* is driven by means of the friction disks *G* and *H*, which are assembled alternately and pressed together by the compression coil spring *I*. Disks *G* are fastened on the end of shank *A* and drive disks *H* which are provided with tongues that extend into grooves in the bevel gear *B*. The detail views of these disks should be of assistance in understanding the manner in which they cause the gear to revolve. When it is desired to produce threads in a hole, the tap is first placed in the drill chuck *J*, then the teeth on the rear end of clutch *E* are brought in mesh with the saw teeth on gear *B*, and the machine spindle advanced until the tap comes in contact with the work. When power is applied, the clutch drives the tapping spindle *K* by means of pin *L*, which passes through a slot in the spindle. The tap draws itself into the hole being tapped, and the entire attachment and the machine spindle are pulled forward as this occurs. The clutch *E* is held in engagement with the gear *B* by the plunger *M*, which is actuated by means of the compression coil spring *N*.

A stop, properly located on the machine, prevents the machine spindle from advancing farther when the tapping operation is completed. However, the tap continues to be drawn into the hole due to the continued rotation of the machine spindle, pulling spindle *K* and clutch *E* with it. This pulling force is sufficient to overcome the pressure exerted by spring *N*, and engagement of the clutch with gear *B* is broken as the high point between the two grooves on the clutch passes the point of the plunger. As soon as this happens, the plunger, being again actuated by spring *N*, is pushed into the next groove on the clutch and forces the teeth on the front end of the clutch to be brought in mesh with the saw teeth of gear *D*. This gear, of course, revolves in an opposite direction to gear *B* on account of being driven from the latter through the intermediate gear *C*. Thus, when the clutch is brought in mesh with gear *D*, the rotating direction of the tap is immediately reversed, causing it to withdraw itself from the hole. The pressure of spring *N* is great enough to hold the clutch in mesh with gear *D* during this movement, so that the entire unit and the machine spindle are returned to their starting positions.

The clutch is again brought in mesh with gear *B* preparatory to another tapping operation by exerting sufficient pressure on spindle *K* to overcome the force of spring *N*, at the same time holding the housing *F* in an immovable position. Handle *O* is provided so the housing can be held from rotating with the shank. It is obvious that by increasing or decreasing the number of driving disks *G* and *H*, the power of the attachment can be altered to suit various sizes of taps. The front end of shank *A* is held in gear *B* by means of a small round nut placed in a counterbored hole in the gear. The spring *P*, which is placed in the same hole, extends into another counterbored hole in the end of spindle *K* and takes up any backlash of the latter that might be produced by the slot in which pin *L* operates.



Tapping Attachment which reverses Rotation of Tap when Operation is completed

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Electrical Speed Control for Cleveland Automatics. Cleveland Automatic Machine Co., Cleveland, Ohio..... 81
Cincinnati Internal Grinding Machine. Cincinnati Grinder Co., Cincinnati, Ohio..... 85
Fitchburg 4-inch "Lo-swing" Lathe. Fitchburg Machine Works, Fitchburg, Mass. 86
Universal Open-side Shaper. Universal Machine & Tool Co., Canton, Ohio 87
Glaude Portable Drilling Machine. Leopold F. Glaude, 930 N. Washtenaw Ave., Chicago, Ill..... 87
Van Keuren Reference Gages. Van Keuren Co., 362 Cambridge St., Boston, Mass..... 87
Lubrication System for Universal Boring Machine. Universal Boring Machine Co., Hudson, Mass..... 88
Jones Slotting Machine. Jones Machine Works, Media and Edgewood Sts., West Philadelphia, Pa..... 89
Griscom-Russell Strainer. Griscom-Russell Co., 90 West St., New York City..... 89
Pletz Screw Press. Carl Pletz & Sons, 717 Sycamore St., Cincinnati, Ohio 90
Sibley Drilling Machine. Sibley Machine Co., 8 Tutt St., South Bend, Ind. 90
Imperial Automatic Acetylene Generator. Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago, Ill..... 90
Improved Hercules Arbor Press. Hercules Machinery Co., 110 Woodbridge St., Detroit, Mich..... 91
Face Grinding Table for Badger Grinder. Badger Tool Co., Beloit, Wis. 91
Guard for Modern Tool Co.'s Grinder. Modern Tool Co., 2nd and State Sts., Erie, Pa..... 92
Features of Cincinnati Planers. Cincinnati Planer Co., Cincinnati, Ohio 92
Grant Automatic Chamfering Machine. Grant Mfg. & Machine Co., 90 Silliman Ave., Bridgeport, Conn..... 93

Electrical Speed Control for Cleveland Automatics

In performing a sequence of machining operations on an automatic screw machine, it is often desirable to rotate the work at different speeds while it is in contact with successive tools of the series, if each tool is to operate under ideal conditions. On the Cleveland Type A machines, this result is accomplished automatically by a mechanism that regulates the amount of resistance in series with the shunt field windings of an adjustable-speed driving motor. Maintenance of the correct cutting speed for each tool assures efficient cutting, satisfactory rates of production, and a good finish on the machined surfaces.

A WIDE range of feed variations are provided on automatic screw machines built by the Cleveland Automatic Machine Co., Cleveland, Ohio. Several years ago it became apparent that if this provision for feeding the tools to the work at suitable rates could be supplemented by an automatically controlled spindle speed changing mechanism which would enable the number of revolutions per minute of the work to be varied to maintain the correct peripheral cutting speed for different tools that are used successively, the machine with such an equipment would be able to obtain a more satisfactory productive efficiency. Over two years were spent on this problem of machine design before a satisfactory solution was evolved, and during this period of development various forms of electrical speed controllers were employed, with provision for their operation either automatically or by hand.

Quite obviously an automatic controller would possess many important advantages over a hand-operated equipment for use on an automatic screw machine. Chief among these is the fact that with automatic control there would be no interference with the quite general practice of having a single attendant look after a number of machines of this type. With a hand-operated controller it would be necessary to have the operator always near the machine in order that he might effect the speed changes at exactly the proper time. The means finally adopted consists of an automatically operated controller that increases or decreases the resistance in series with the shunt field windings of an adjustable-speed motor, thus varying the peripheral speed of the work to suit the different tools.

General Description of the Machine

Cleveland automatic screw machines equipped with this automatically operated adjustable-speed mechanism are

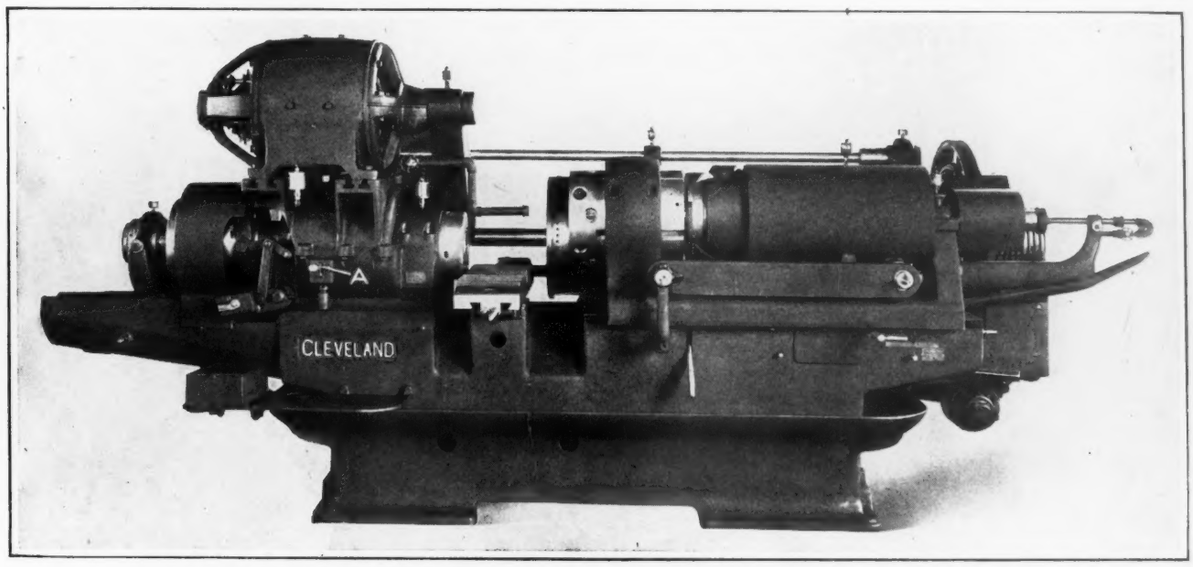


Fig. 1. Front View of Large Cleveland Automatic equipped with Automatically Controlled Adjustable-speed Driving Motor

known as Type A automatics and in the 1½-, 2-, 2½-, 3-, and 3½-inch sizes they are equipped with two electric motors. One of these is an adjustable-speed reversible or so-called planer type of motor which is used for driving the spindle only. The other is a small constant-speed motor that is utilized to drive all other parts of the machine including the patented automatic spindle speed controller. On the larger sizes of Cleveland automatics only one electric motor is employed, this being the standard equipment for the Type A machines of 4½, 5½, 6¾ and 7¾ inches capacity.

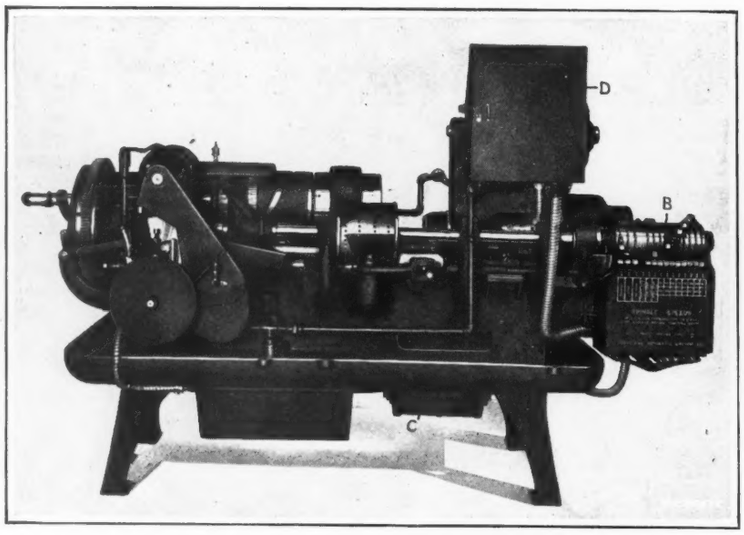


Fig. 2. Rear View of a Smaller Cleveland Automatic equipped with Automatically Controlled Adjustable-speed Spindle Driving Motor, and Constant-speed Motor for driving Other Parts of the Mechanism

On the small sized machines provision is made for automatically obtaining eight changes of spindle speed through the electrical controller, and by means of a cam-operated solenoid it is possible to actuate a clutch that engages either the high- or low-speed gears, so that a total of sixteen spindle speeds is available, giving a range of ten to one in either direction at any point in the cycle. This applies to Cleveland Type A automatics in sizes up to 3½ inches, inclusive.

The four larger sized machines are not furnished with back-gears, so that only eight changes of spindle speed are available, and as it is not required to perform threading operations on work handled on the larger sizes of machines, no provision is made for reversing the direction of spindle rotation. As only one motor is used on the large automatics, in addition to driving the spindle, the power is transmitted from this motor to a shaft running along the back of the machine to carry movement to all other members of the machine. Aside from the provision for adjusting the spindle speed, the design of these Type A automatics is essentially the same as that of other machines built by this company.

How the Automatic Control of the Spindle Speed is Obtained

Having made a general statement as to the arrangement of the controller mechanism of the Cleveland Type A automatics, we are in a position to give a detailed description of the arrangement of the special equipment provided for this purpose and of the manner in which it functions. It will be desirable to obtain an idea of the relationship of the spindle speed control and reversing mechanism to the other parts of the machine, and this can best be done by referring to Figs. 1 and 2 which show front and rear views of two different sizes. Referring to Fig. 1 it will be seen that there is a push-button at *A* that operates the main switch and provides for starting and stopping both motors. Next turning attention to Fig. 2, it will be noticed that there is a drum *B* mounted at the end of the main camshaft; this camshaft also carries other cams which time or synchronize all of the automatic movements of the machine. The number of cams mounted on drum *B* will vary according to the size of the machine, that is to say, upon whether or not provision is made for doubling the number of spindle speeds obtained through the controller by the engagement of high- or low-speed gears, and for reversing the direction of rotation of the spindle.

For the purpose of this description it will be best to consider the equipment used on machines of sizes up to 3½ inches, inclusive, and in these cases the cam-drum *B* carries three cams that provide for starting, stopping, and reversing the spindle driving motor, respectively; there are also two cams for engaging the high- and the low-speed gears, and eight cams operate the controller to obtain any of the available speeds which it provides. A clearer idea of the arrangement of this part of the mechanism, and of the way in which it functions will be gathered by referring to Figs. 3 and 4, which show close-up views of the controller cam-drum and of the auxiliary mechanism. In Fig. 3 it will be seen that on the cover plate over the box is marked, opposite each lever, the functions performed by the several cams carried

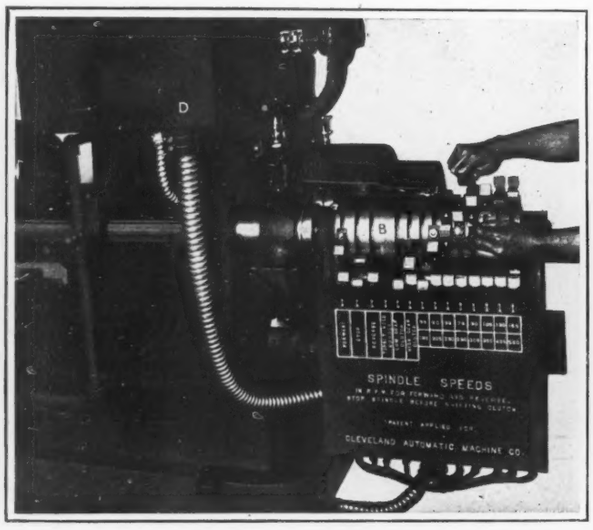


Fig. 3. Close-up View of Mechanism for automatically starting, stopping, and reversing the Spindle, engaging High- and Low-speed Gears and changing the Speed of Rotation

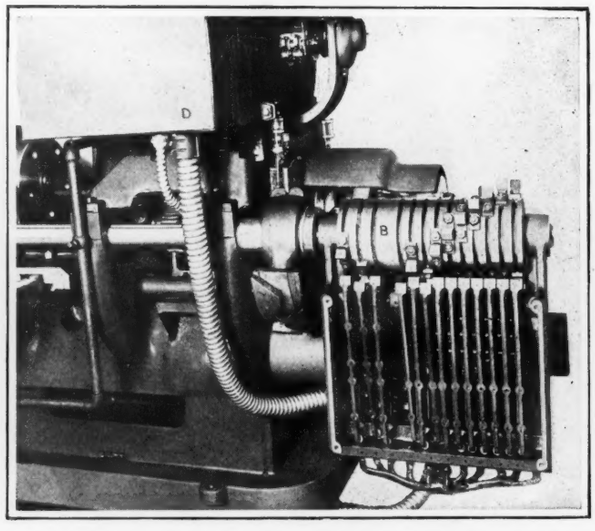


Fig. 4. Close-up View of Patented Automatic Controller for Adjustable-speed Spindle Driving Motor, with the Cover Plate removed to show the Arrangement of the Operating Mechanism

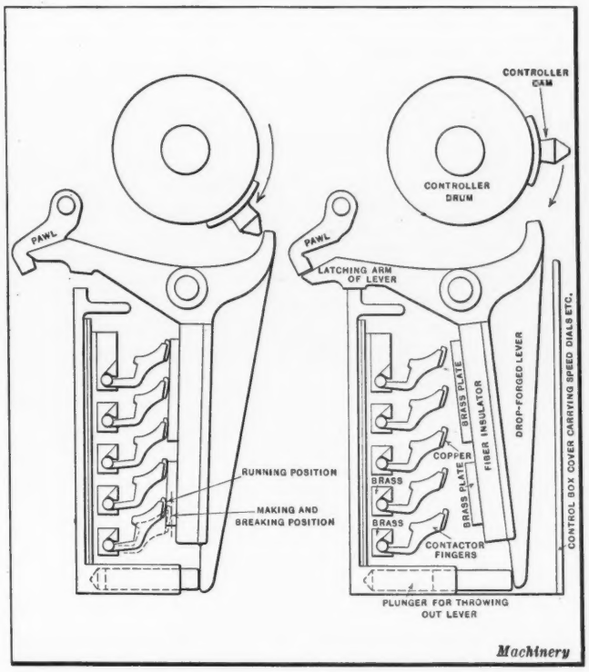


Fig. 5. Arrangement of Control Box Mechanism, showing Contactor Fingers in Disengaged and Running Positions

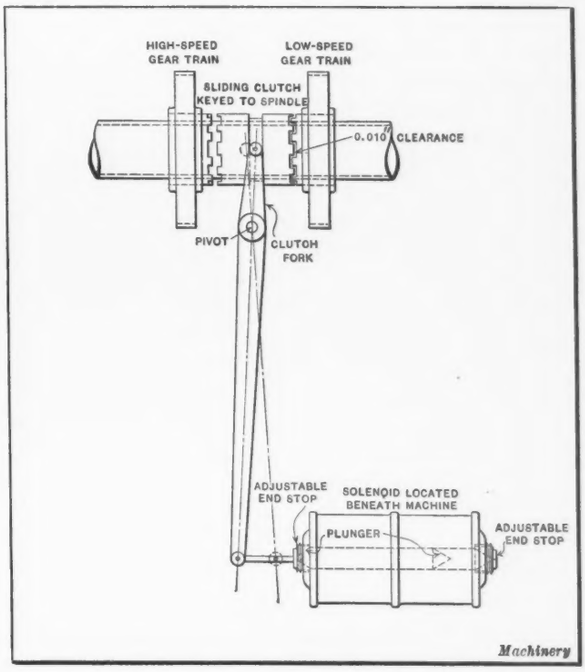


Fig. 6. Arrangement of Solenoid-operated Clutch for automatically engaging the High- and Low-speed Gears

on drum *B*, and in the case of the eight cams that effect changes of speed, information is given concerning the speeds that are secured with each cam when the spindle is driven through the high-speed and through the low-speed gears.

In Fig. 4 the cover plate has been removed from the box to show the interior, and this illustration, in conjunction with Figs. 5 and 6, will give the reader a good idea of how the mechanism operates. Each of the cams carried by the drum *B* comes into engagement with its respective controller lever at some point in the revolution of the camshaft. In the case of speed changes, the desired result is accomplished by eight cams which come successively into engagement with their respective controller levers and throw over contact levers that bring contactors carried by the levers into engagement with corresponding contacts in the controller box. In this way, the amount of resistance that is in series with the shunt field windings of the adjustable-speed driving motor may be changed, in order to rotate the work at a suitable speed for the tool in the operating position.

Particular attention is called to the manner in which this engagement is effected through a combination rubbing and rolling action that tends to keep the surfaces of the contacts clean so that a satisfactory electrical connection will always be secured. Engagement of either the high- or low-speed gears is secured through two cams and control levers that operate a solenoid carried in a case shown at *C* in Fig. 2. This mechanism is also illustrated diagrammatically in Fig. 6, where it will be seen that when the solenoid is energized in one direction it throws the high-speed gear into engagement; and energizing the solenoid in the opposite direction results in engagement of the low-speed gear. Similarly, the three remaining cams on drum *B*, Fig. 2, actuate control levers that engage contacts for driving the motor in the forward or reverse direction, or for stopping its rotation.

Only one lever in the row can have contact at a time, because as the next lever is brought into engagement with the contactor fingers, the latching arm of the incoming lever raises the pawl, thus letting the other arm which is in

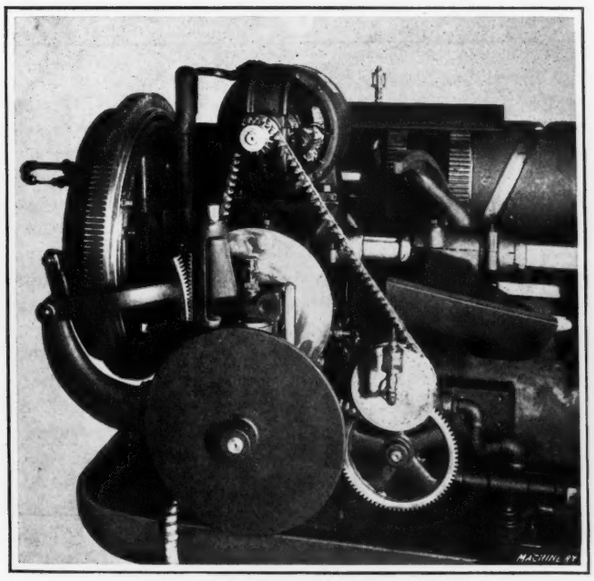


Fig. 7. Close-up View of Constant-speed Motor for driving All Members of the Mechanism except the Spindle

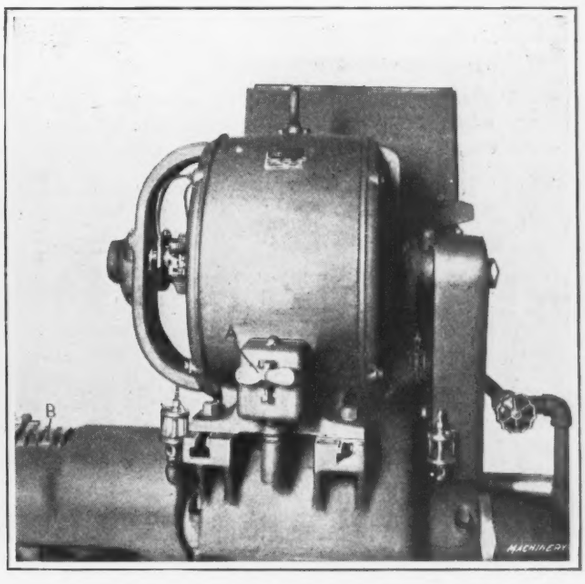


Fig. 8. Close-up View of the Adjustable-speed Motor which is automatically controlled to give Required Spindle Speeds

contact fall out of engagement. This is a very simple operation, and the attendant is not required to bother about what lever is in the operating position. It is merely necessary for the set-up man to locate each cam on the controller drum to give the proper cutting speed for the tool that is in the operating position, and then when the next tool is advanced to the work, the corresponding cam on the drum will come into action and provide for rotating the work at the proper speed for this tool.

Fig. 5 shows the contactor fingers in two positions, namely, disengaged and running; and Fig. 6 shows the solenoid-operated clutches that provide for automatically engaging the high- and low-speed gears. The solenoid plunger comes tightly to rest against a stop at either end, and there is a slight air-cushion effect. In order to prevent the clutches from causing any end thrust against the spindle bearings, the stops, Fig. 6, are adjusted so that the clearance between the top of the sliding clutch tooth and the bottom of the engaging clutch space is 0.010 inch.

When the camshaft and drum *B*, Fig. 2, have made one complete revolution, each of the cams carried by the drum has performed its function and the finished piece of work has been cut off from the bar. Then the stock will be advanced to provide for repeating the sequence of operations for producing the next piece of work, this cycle being continued indefinitely without requiring attention from the attendant except to replenish the stock. There is a control panel *D*, Fig. 2, located at the rear of the spindle driving motor, that contains the main switch, accelerators, and overload coils for both motors. By having both of the overload coils operate the main switch, the two motors are interlocked electrically and an overload on either motor will stop the whole machine.

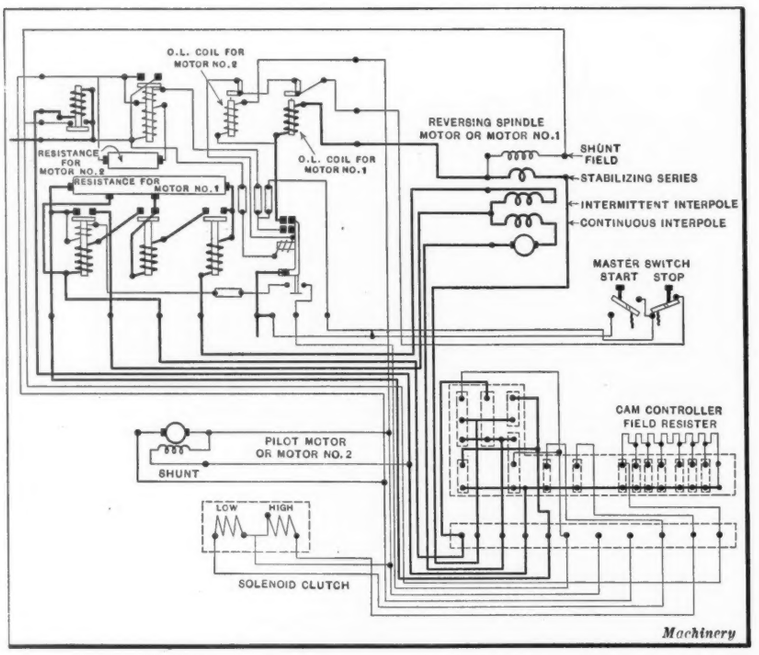


Fig. 9. Wiring Diagram of the Automatically Operated Speed Controller

Conclusion

The advantages claimed for this design, in addition to the benefits of individual motor drive, include the following features: The machines are easily set up and changes of spindle speed can be effected from a standing position as readily as changes in feed. Production is increased because the cutting speed is always maintained at a rate that is most efficient for the nature of the work that is being performed. As a case in point, consider the performance of a cutting-off operation. The peripheral speed can be held constant by increasing the speed at which the work is rotated as the tool approaches the center. This is but one of the numerous ways in which the automatic variable-speed mechanism is found useful. As another example, consider a case in which a wide range of speeds is required, as when threading with a solid die. A low surface speed is necessary for threading, while the other operations on the same piece will require much higher speeds. With the control mechanism described all operations can be performed at suitable speeds.

SPINDLE SPEEDS FOR CLEVELAND TYPE A AUTOMATICS

Machine Size, Inches	Low-gear Clutch — Spindle Speeds in R. P. M.								High-gear Clutch — Spindle Speeds in R. P. M.								Motor Data[1]		Index Time in Seconds	
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	Horse-power Required	Speed Range		
1½	84	99	115	135	157	184	216	252	280	328	384	449	525	614	718	840	2½	3:1	20	2 Motors
2	55	60	68	78	90	105	130	165	185	205	230	260	300	355	435	550	5	3:1	20	2 Motors
2½	50	55	60	70	85	95	115	150	167	185	205	233	270	315	390	500	7½	3:1	30	2 Motors
3	40	43	48	55	63	75	90	120	130	145	162	185	212	252	310	400	10	3:1	35	2 Motors
3½	37	43	50	59	69	80	99	110	125	146	171	200	234	274	320	375	10	3:1	35	2 Motors
4½	70	85	104	127	154	188	229	280	No Clutches or Reverse								15	4:1	40	1 Motor
5½	55	67	82	100	121	148	181	220	No Clutches or Reverse								15	4:1	40	1 Motor
6¾	45	55	67	82	99	121	147	180	No Clutches or Reverse								20	4:1	40	1 Motor
7¾	40	49	60	73	88	108	131	160	No Clutches or Reverse								20	4:1	40	1 Motor

Machinery

[1]Note: Adjustable motor taking 115- or 230-volt direct current.

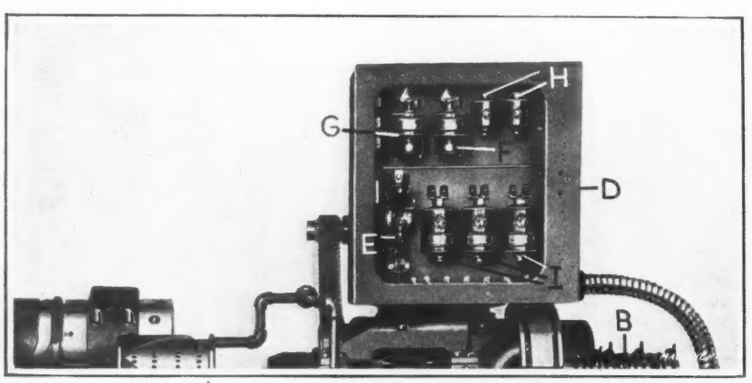


Fig. 10. Control Panel with Cover removed: (E) Main Switch for Both Motors. (F) and (G) Overload Coils for Large and Small Motors, respectively. (H) and (I) Accelerators for Small and Large Motors, respectively

CINCINNATI INTERNAL GRINDING MACHINE

A No. 9 internal grinding machine has recently been developed by the Cincinnati Grinder Co., Cincinnati, Ohio. It is a production machine designed for the single purpose of grinding straight or tapered holes, and the aim has been to provide a grinder that is especially adapted for the rapid production of accurate work. This machine embodies the principle of a fixed work-base and a moving wheel-head, with centralized control that makes the machine easy to operate and eliminates non-productive movements of the operator which impair his efficiency and retard production. The machine is fitted with speed- and feed-change boxes that furnish a correct range of speeds and feeds, any one of which may be instantly obtained while the machine is running.

A self-contained drive which requires only a single pulley on the lineshaft or a motor on the floor connected by a silent chain and sprocket is another feature of this machine. The headstock revolves the work by direct belt drive and there is an automatic cross-feed with a direct-reading scale for indicating the amount of stock that has been removed from the work. These machines are manufactured on the unit system of construction. All plain bearings are scraped to master surface plates and straightedges, and the shaft journals are ground to size. These journals are supported in removable bushings that may be easily replaced when they become worn, without disturbing the alignment of the shafts. All sliding surfaces and revolving parts are provided with liberal and sufficient means for lubrication. Having made this preliminary statement concerning features of the machine, we are ready to present a detailed description of the arrangement of important parts of the mechanism.

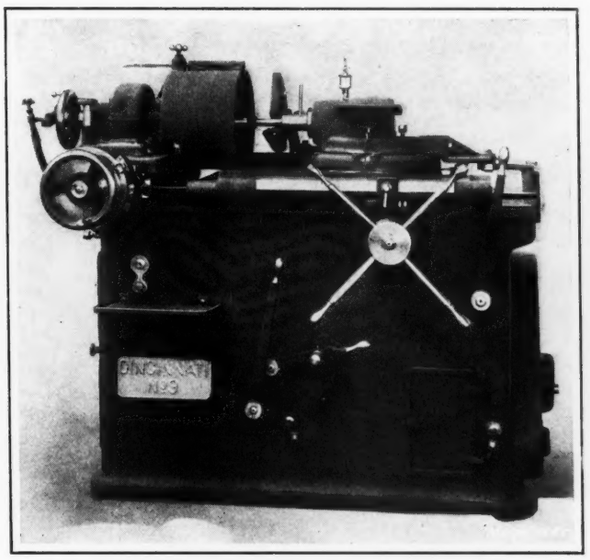


Fig. 1. No. 9 Internal Grinding Machine built by the Cincinnati Grinder Co.

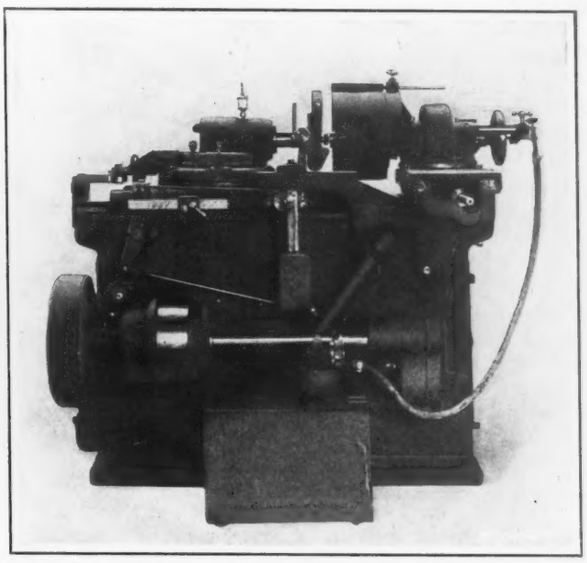


Fig. 2. Opposite Side of the No. 9 Cincinnati Internal Grinding Machine shown in Fig. 1

Work Done on the Machine

This machine is particularly adapted for the internal grinding of straight or tapered holes in such parts as can be revolved when held in a chuck or on a faceplate. It readily lends itself to the rapid and economical finishing of holes that are true both as regards diameter and length, and duplicate pieces can be ground to identical dimensions. This machine is especially suited for grinding holes in gears, collars, cylinders, connecting-rods, bushings, ball bearing rings, roller bearing rings, sleeves, gages, and all work of like character which comes within its range. Face grinding can be conveniently done in correct relation to and in connection with the grinding of the hole, on the external face of rings, collars, cones, and all similar pieces, and also on the shoulder in the bore. This is accomplished by substituting a cup-wheel for the usual straight-sided wheel, using the face of the former for grinding the shoulder and the periphery for grinding the hole. Whenever it is imperative that the hole and the face of a part be finished accurately square with each other, it is essential that both surfaces be ground at the same setting. Should separate settings be made, the resultant accuracy would be wholly dependent upon the closeness of the chucking which might not be within the fixed tolerance. In face grinding, the position of the wheel remains unchanged, but the work-head is traversed.

Arrangement of the Mechanism

The design consists mainly of a swiveling wheel-head carried upon a sliding table, having provision for longitudinal motion, but not being movable crosswise; a work-head mounted on a cross-slide in such a manner as to provide a sidewise movement for adjusting and feeding the work to the wheel; an automatic reverse plate mounted on the front of the base for controlling the reversal of the table; a gear-box, contained in the automatic reverse plate, for varying the speed of the table; an automatic feeding device connecting the automatic reverse plate with the cross-slide feed; a gear-box on the rear of the machine for controlling the rotative speed of the work; a truing-diamond carrier always in position on the machine; a coolant tank and piping; and a complete set of water guards.

As it is entirely self-contained, the machine may be driven by a single pulley from the lineshaft, by a pulley from an intermediate or jack-shaft, or by a motor through a silent chain and sprocket. From the main driving shaft at the rear, motion is transmitted to the wheel-head by a belt running from a pulley on the end of the main shaft to a pulley on the drum shaft. From the drum, which is hung in ball bearings and located in the base of the machine, power is carried directly to a pulley on the wheel-spindle through an endless belt running over a set of two idler pulleys, one of which is fixed and the other floating. The weight of the latter compensates for changes in belt center distances when using different sizes of wheel-spindle pulleys.

The grinding wheel is held on a spindle carried in a cylinder, tapered on the outside and mounted in a hole of corresponding taper in the wheel-head housing, in which it is secured by a lock-nut. A range of wheel-heads from the maximum to the minimum capacity of the machine is available. Each head is a complete unit in itself, being made

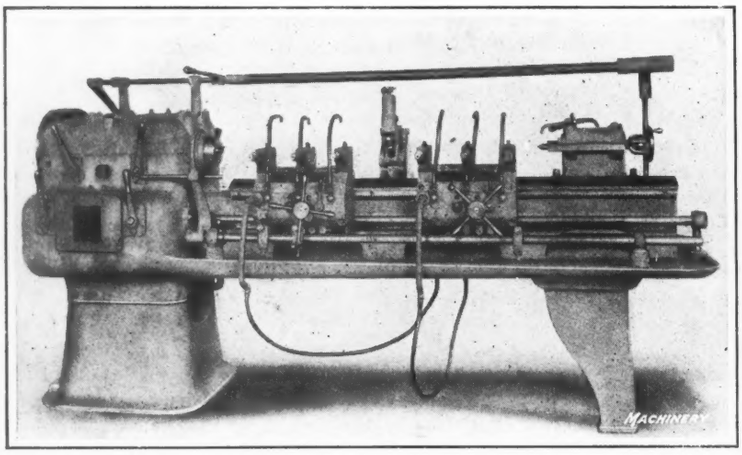


Fig. 1. Front View of 4-inch "Lo-swing" Lathe

interchangeable with all other heads. This arrangement permits of quickly substituting a head of different size when changing from the grinding of large holes to small holes or the reverse, with the additional advantage that no adjustment of the wheel-head is required when making the change. The diameter of the driving pulley on each wheel-head is made proportional to the diameter of the grinding wheels to be used on the spindle, so that the correct peripheral speed of the wheels suitable for use on any given spindle is automatically provided.

Although the wheel-head has no crosswise motion, it is capable of being swiveled 30 degrees from the normal position, thus providing ample room for gaging the work, or for placing it in or removing it from the machine with dispatch and without danger of the operator coming into contact with the wheel. The wheel-truing fixture is carried on a bracket at the rear of the machine and is never removed. It can be quickly located in proper relation to the wheel, and once in position remains fixed until a hole of another depth is ground, when it is reset. The arm holding the truing diamond may be instantly brought into the operating position, and as speedily thrown out of the way when it is not in use.

Forward and reverse movements of the wheel-head are obtained through the reciprocating motion of a sliding table. The direction and speed of this movement are controlled by an automatic reverse plate mounted on the front of the machine, which contains a clutch of the load and fire type and a gear-box supplying three changes of speed. Power is delivered to this gear-box by means of a silent chain drive running from a constant-speed sprocket in the gear-box on the rear of the machine. This latter box contains the necessary mechanism for controlling the revolutions of the work-head, receives its power from the main driving shaft through spur gears, and furnishes three speeds for the rotary movement of the work. Motion is transmitted to the work-head from a pulley in the box, by a belt, running over a set of idlers, one of which is fixed and the other adjustable so as to give proper belt tension.

This pulley is arranged with a driving clutch which is operated from and automatically disengaged by a trip actuated by the sliding table whenever the wheel-head is swiveled out of its normal position for gaging the work, or for loading or unloading the machine. Simultaneously with the releasing of the clutch, a brake is applied to the pulley, the combined action of the two instantly stopping the rotation of the work. The work-head is capable of being swiveled for taper grinding to an angle of 45 degrees or less, the swiveling being accomplished by means of a handwheel at its top, through a shaft and pinion, the latter meshing with a gear segment on the circular base of the work-head.

Power feed to the cross-slide, which carries the work-head, is received from the automatic reverse plate through a pawl and ratchet, the former being operated from a link set in motion by the table reverse lever. A cylindrical adjusting nut with direct-reading graduations is carried by the link, for varying and indicating the amount of feed. The action is automatic, and the feed movement occurs at each end of the table travel; it may be varied and may also be set to trip at any predetermined point. A mechanism consisting of a simple thumb-latch is provided for fine feeding by hand, and a handwheel is available for rapidly traversing the cross-slide. The cross-slide screw is fitted with a direct-reading circular scale, for indicating the amount of stock removed, and with positive stops for use in the production of duplicate diameters.

The tank is proportioned to hold an adequate supply of water, and it carries the pump. It is separate from the machine, being set on the floor under the main driving shaft, from which a belt runs to the driving pulley of the pump, as shown in Fig. 2. The sedimentation compartment frees the coolant from grit, passing only a clean mixture to the pump chamber for repumping, and thus insuring at all times a flow of clean water to the work. The water guards are detachable from the machine; they are sufficiently large and suitably placed to thoroughly protect the operator and the floor by catching the water splash and spray and returning it to the settling tank.

FITCHBURG 4-INCH "LO-SWING" LATHE

The Fitchburg Machine Works, Fitchburg, Mass., have recently developed and placed on the market another machine, having all the standard "Lo-swing" characteristics. This lathe is designed to handle work up to 4 inches in diameter. It is built in three regular sizes, the maximum capacities for each permitting actual machining lengths of 60, 84, and 108 inches, respectively, these being the distances from center to center. This lathe is of the all-geared head type, and in general construction follows very closely that of the 8-inch size, a complete description of which was published in the October, 1916, number of MACHINERY.

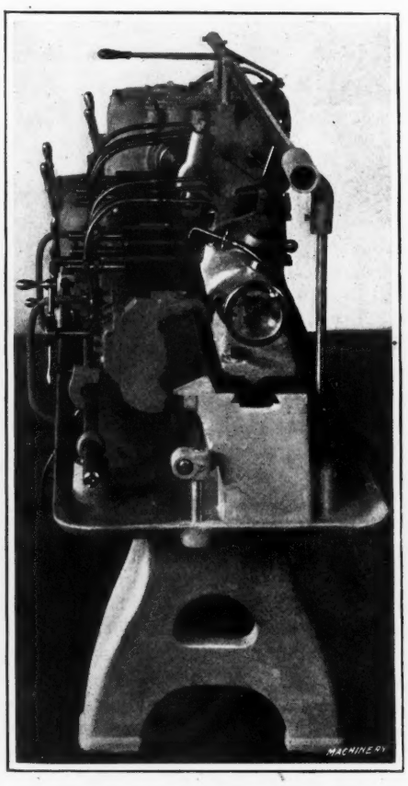
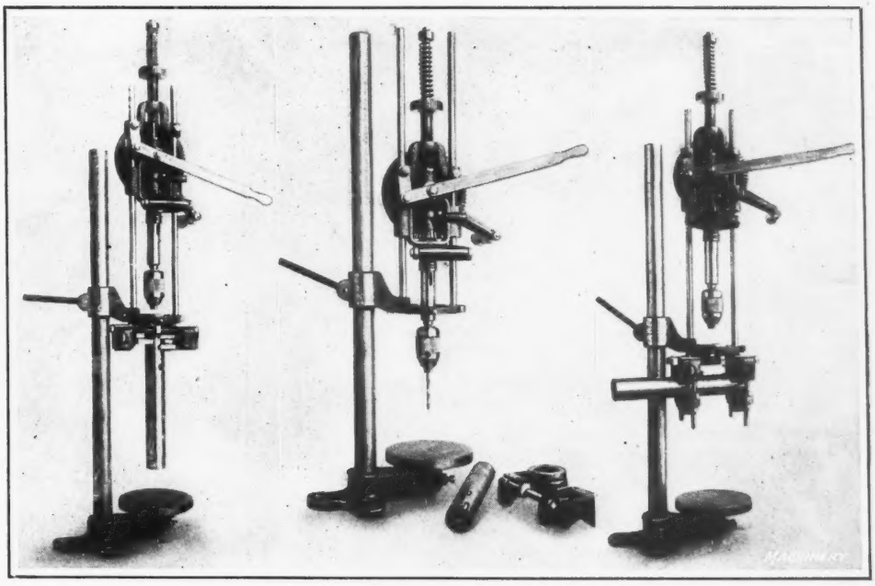


Fig. 2. End View of Machine shown in Fig. 1

In the smaller model here described it has been found advantageous to place the intermediate shaft in the geared head on the same level with the spindle and back-gear shaft, rather than above it as in the earlier model. This lowers the top of the headstock casting but does not alter the method of driving the spindle. The two illustrations here shown furnish an excellent idea of the appearance of the machine, from which it will be

seen that no radical departures in design from other lathes of this company's manufacture have been made. The driving pulley has a constant speed of 500 revolutions per minute, from which there may be obtained six spindle speeds ranging from 38 to 316 revolutions per minute. The two upper levers on the geared head are the ones used to compound the spindle speeds, while the two lower levers are those used to regulate the feeds, of which there are nine, ranging from 0.007 to 0.120 inch per spindle revolution.

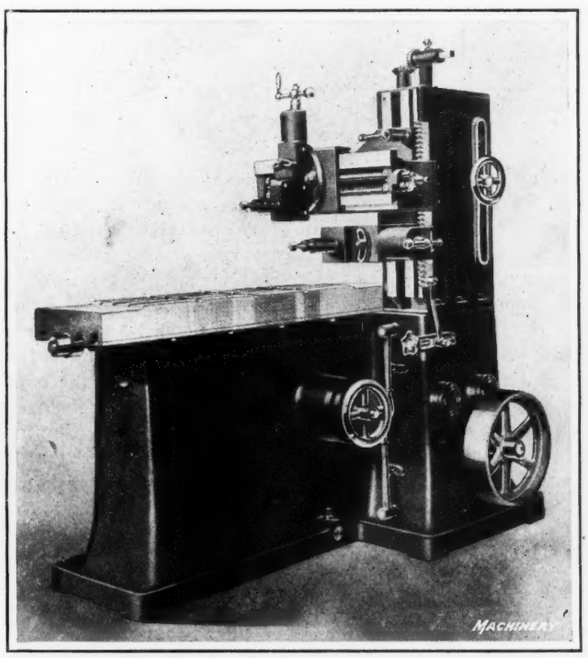
A single clutch-operated pulley obviates the necessity of employing a countershaft, so that the lathe may be belted directly to the lineshaft or to the motor as desired. The over-all lengths of the machines from the foot end to the outside of the pulley shaft at the head end are 123⅛ inches, 147⅛ inches and 171⅛ inches, respectively, for each of the three regular lengths in which this lathe is manufactured. The height from floor to the line of centers is 42 inches; to top of clutch shifter (over-all), 55⅝ inches; over-all depth, from extremity of handle on carriage capstan wheel to rear of pulley, 37½ inches; and width of base, front to back, 28¼ inches.



Three Views of the Portable Drilling Machine built by Leopold F. Glaude

UNIVERSAL OPEN-SIDE SHAPER

In the accompanying illustration there is shown a 24-inch open-side shaper and planer which is a recent product of the Universal Machine & Tool Co., Canton, Ohio. The principal feature claimed for this machine is that it combines the advantages of both a planer and a shaper. It will be seen that the column is at the right-hand side which, with the arrangement of mechanism on the machine, enables the operator to control it without going from one side to the other. It also takes any large work which necessitates overhanging the table, and permits of operating the machine without having the work hinder the operator. Four changes of speed are obtained by levers at the operator's side, giving speeds of 7, 20, 30, and 40 strokes per minute.



Open-side Shaper or Planer built by the Universal Machine & Tool Co.

GLAUDE PORTABLE DRILLING MACHINE

Leopold F. Glaude, 930 N. Washtenaw Ave., Chicago, Ill., is now building a portable universal drilling machine which is here illustrated and described. This tool is equipped for the performance of various operations such as centering, keyseating, etc., in addition to the work of actually drilling holes. It is a universal portable drilling machine, and can be adapted for numerous purposes, such as drilling holes in pipes or shafts and centering round or square pieces of work. By using an end-mill in the spindle and clamping the work in a V-block, leaving the clamping strap on another V-block slightly loose so that the shaft can slide, this outfit may be utilized as a portable keyseating machine, the desired movement being obtained by turning the screw with the right- or left-hand thread. A two-speed change-gear is provided that can be readily changed; and there is a screw and lever feed. The machine can be rigged up with a motor or flexible shaft for use by power; and it is well suited for handling various kinds of repair work such as that which is met with in garages, machine shops, etc. The centering attachment has a chuck which can be revolved by hand or kept stationary. The total weight of the machine is 45 pounds.

VAN KEUREN REFERENCE GAGES

The Van Keuren Co., 362 Cambridge St., Boston, Mass., has added to its line of modern measuring tools, various sets of combination precision reference gages. These gage-blocks are designed and manufactured primarily as reference standards of the highest type. They are cylindrical in shape and ⅞ inch in diameter, affording a particularly large flat contact face, which insures long and uniform wear both in regard to flatness and parallelism of faces, and length. The round or cylindrical shape is said to be of particular advantage in that it affords the ideal distribution of metal for a reference standard, as the results of temperature change affect the block evenly. The gages are made of a high-grade alloy tool steel, especially selected for its properties in providing long wear, constancy of size, freedom from corrosion, and uniformity of physical properties. Before being used, the steel is subjected to a scientific heat-treatment and seasoning process.

Each gage is carefully lapped to a mirror finish, and is guaranteed to be of the correct size within 0.00001 inch of the nominal marked dimension. The degree of accuracy of the flatness and parallelism of faces permits the blocks to be calibrated within a few millionths of an inch where additional accuracy is required. Each gage is standardized by light wave measurement, with standards that are certified by the National Bureau of Standards, and a serial number is stamped on each gage to facilitate the keeping of records as to the accuracy of the gage when new or during its life. The gages are arranged in various sets to meet the requirements both of large manufacturing concerns and individual

Combination Precision Reference Gages made by the Van Keuren Co.

mechanics. A particularly useful set, here illustrated, contains five sizes in the binary fractions of an inch, namely, 1, ½, ¼, ⅛, and 1/16 inch. With this set all sizes in sixteenths of an inch may be assembled in combination, making thirty-one sizes in all, which provide the common sizes used in everyday shop work.

LUBRICATION SYSTEM FOR UNIVERSAL BORING MACHINE

Benefits derived through the performance of metal-cutting operations under a constant flow of lubricant or coolant have led the Universal Boring Machine Co., Hudson, Mass., to

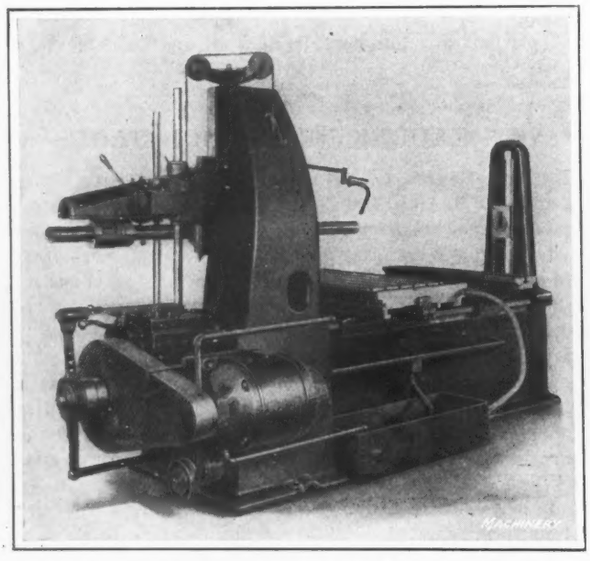


Fig. 1. Universal Boring Machine equipped with an Improved Lubricating System

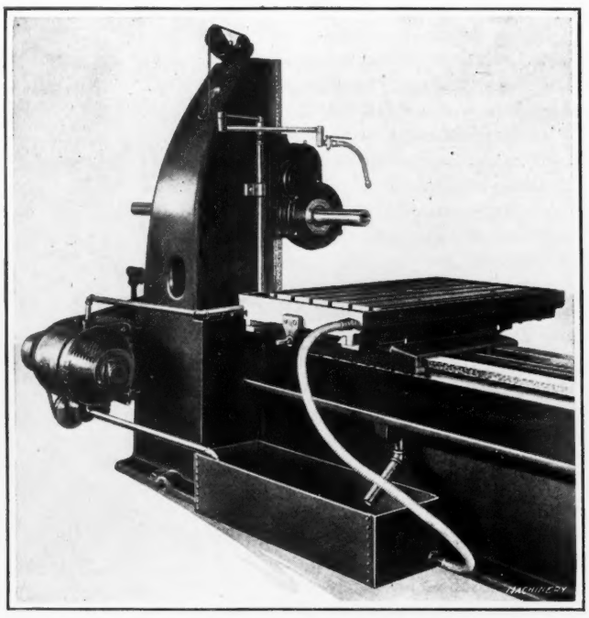


Fig. 2. Opposite Side of the Universal Boring Machine shown in Fig. 1

provide its machines with an improved equipment for circulating and collecting a cooling fluid. It is generally known that the purpose of a coolant is to assist in carrying away heat from the point where work is being done by the cutting tools, thus keeping the temperature of the tool steel below the point where softening starts to occur. As experience has shown it to be a better policy to use too large rather than too small a volume of coolant, the pump and piping on Universal boring machines have a capacity for delivering twelve gallons per minute to the tools and work.

The type of pump which is used cannot lose its prime and the system cannot become clogged, because anything that can pass through the intake will be passed by the pump and

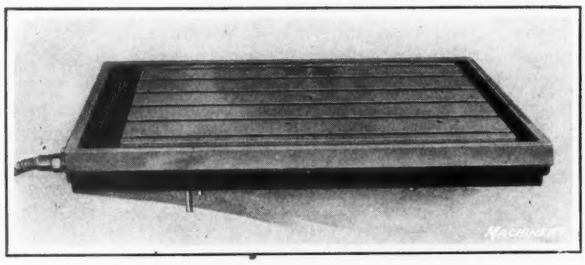


Fig. 3. Table of the Universal Boring Machine showing Arrangement of Oil Pockets

all other parts of the system, there being no openings smaller than the ¾-inch intake. The impeller pumps by centrifugal force, and any chips that can enter pass right through the system, thus making it unnecessary to use strainers. Oil troughs are provided on the front and back of the bed and they slope toward the center. The front trough is higher than the one at the rear. Lubricant is carried by a 1¾-inch pipe from the center of the front trough through the bed to the center of the rear trough, and from there into the tank. The troughs project 4¾ inches and they are 4 inches deep.

Between the ways on top of the bed there is a surface that slopes toward the center to join a rectangular trough 16 inches in length, from which the lubricant is carried into the tank. The table has oil pockets on each end and grooves in the T-slots, and it delivers the lubricant toward the rear. From there it is carried by a flexible tube into a tank at the rear. The pump is attached to the motor bracket and is driven by a belt from the motor shaft. It has a capacity of twelve gallons per minute and the lubricant is carried from the pump to the tool by piping and elbows, with a flexible tube nozzle to deliver the flow in any direction.

JONES SLOTTING MACHINE

The Jones Machine Works, Media and Edgewood Sts., West Philadelphia, Pa., is now building a 20-inch slotter which was designed to meet the requirements of shops following the latest practice in performing slotting operations with high-speed steel tools. This machine is proportioned to withstand severe stresses incident to the handling of heavy work. It is equipped with single-pulley drive and furnished with a two-speed countershaft or a direct connection to a constant- or variable-speed motor which develops 10 horsepower. Four changes of speed are available, ranging from 8 to 16 strokes per minute with a constant-speed motor, or 8 to 42 strokes per minute with a variable-speed motor or a two-speed countershaft. All bearings are bronze-bushed and equipped with sight-feed lubricators except on the change-gears, quick-return mechanism, and quick traverse, where flooded lubrication is employed.

Arrangement of the Mechanism

The machine is driven by a powerful friction clutch *A*, and there is a brake for stopping the ram. The clutch, when engaged by handle *B*, which can be operated from either side of the machine, drives a change-speed shaft on which there are mounted four hardened steel sliding gears that are brought into engagement with hardened steel gears on the driving shaft by a hand-lever *C*. Mounted on the end of the driving shaft there is a steel pinion which engages the bull gear wherein the quick-return mechanism is mounted, which is flooded with oil. The ram and crank drive mechanism follow the customary design, with the exception of improvements in the link connecting the counterweight and ram.

The feeds for the saddle, cross-slide, and circular table are of the customary intermittent ratchet feed type, and an attempt has been made to put all the operating handles within easy reach of the operator. These handles are duplicated on the opposite side of the machine for the convenience of the operator when machining special work that would necessitate his being on the opposite side of the machine; also, it is a wise provision from the viewpoint of safety. Handle *D* operates a clutch starting and stopping the feeds on the saddle, and handle *E* operates a clutch starting and stopping the feed on the cross-slide and circular table. The advantages of having the clutch handles as shown are apparent, making it possible to start and stop the feeds instantly.

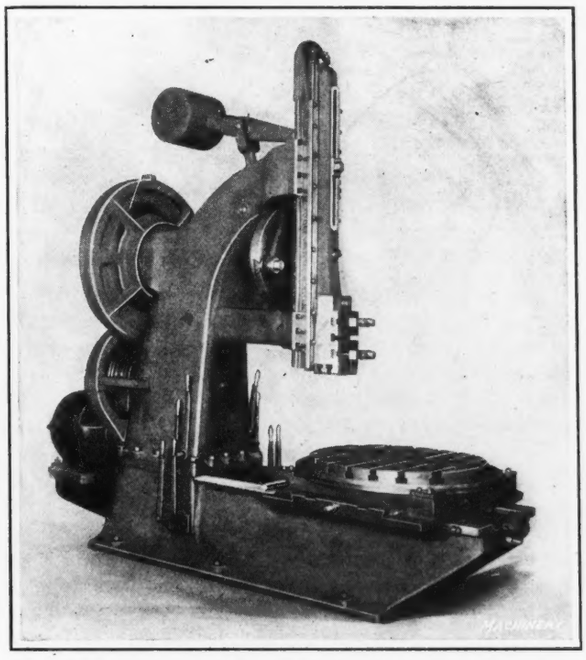


Fig. 1. 20-inch Slotter built by the Jones Machine Works

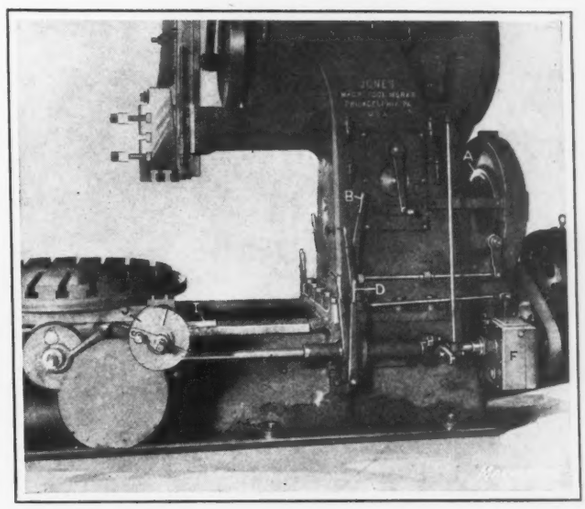


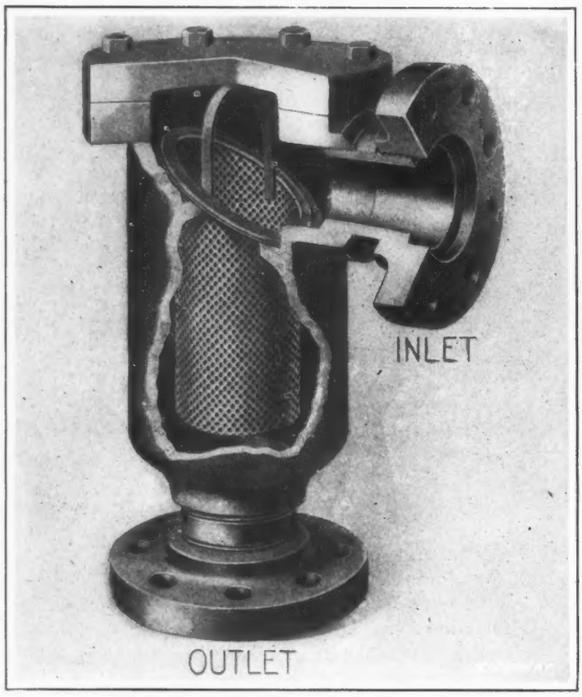
Fig. 2. Close-up View of the Mechanism from Opposite Side of the Jones Slotter

A quick traverse by power for the saddle, cross-slide, and circular table has been incorporated into this slotter, making it easy to operate. To accomplish this result, a quick-traverse gear-box *F* of simple design is driven by a belt from the main clutch shaft and located in line with the main feed-shaft *G*. This gear-box has mounted therein two steel clutch gears and two steel pinions, and carried on the same shaft as the clutch gears there is a double-ended cone friction clutch. The gears are at all times flooded with oil, as they are running all the time that the machine is working. The main clutch for operating the ram does not have to be thrown in to operate the quick traverse. To rotate the feed-shaft, pull the operating handle *H* to a forward position which will rotate the feed-shaft in one direction, and by holding the handle in a backward position, the feed-shaft will run in the opposite direction. It is necessary to hold the handle in the respective positions for operation, for when released it moves to a neutral position. The advantage of the use of a belt for driving the quick-traverse box is that it provides for safety in case the saddle, cross-slide, or circular table should come into contact with any obstruction or to the end of their respective travels.

Another improvement has been made for the operation of the cross-slide feed-screw and the worm-shaft of the circular table. The feed-gears are in constant mesh and do not necessitate the removal of the gear for the cross-slide screw and placing it in position for the circular table feed. The cross-slide screw and circular table worm-shaft have thereon small toothed clutches which are operated by handle *I*, so that when one clutch is in the working position, the other clutch becomes idle, making it impossible to engage both clutches simultaneously. The circular table, which is graduated on its periphery, is also equipped with the well-known indexing mechanism found on the milling machine. This indexing mechanism *J* is of great advantage to the operator for accurately spacing the teeth on large gears or any other work that would require spacing to any angle or a fraction thereof.

GRISCOM-RUSSELL STRAINER

Strainers are required on the suction and discharge lines of lubricating oil, fuel oil, and quenching oil systems for the removal of solid foreign material that is held in suspension in the oil. Also, power plants which secure their water supply from such sources as rivers or lakes require strainers to be placed on the intake lines to prevent weeds, sticks, water plants, and small fish from entering the pipe lines. For such classes of service, the Griscom-Russell Co., 90 West St., New York City, has placed on the market a device known as the G-R strainer, which is shown in the accompanying

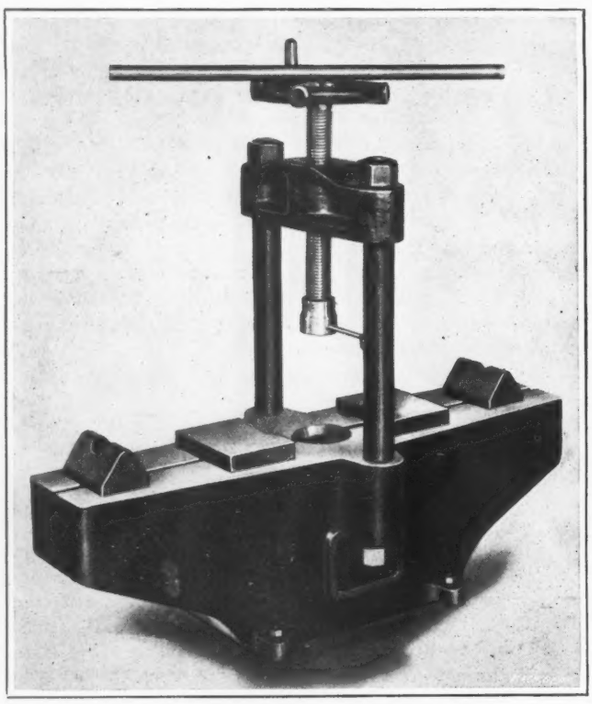


Oil Strainer manufactured by the Griscom-Russell Co.

illustration. The body is constructed of cast iron, and the strainer basket of perforated sheet steel, lined with wire mesh when the strainer is to be used on an oil line. The G-R strainer is of the single type and may be installed either as a single unit or as a strainer set consisting of two strainers connected. This set includes two three-way valves and the necessary connecting elbows, unions, and nipples. Its use permits the cleaning of either of the two units without interruption of the service.

PLETZ SCREW PRESS

Carl Pletz & Sons, 717 Sycamore St., Cincinnati, Ohio, are now building in Nos. 3 and 3½ sizes the screw press which is here illustrated and described. Both sizes use the same



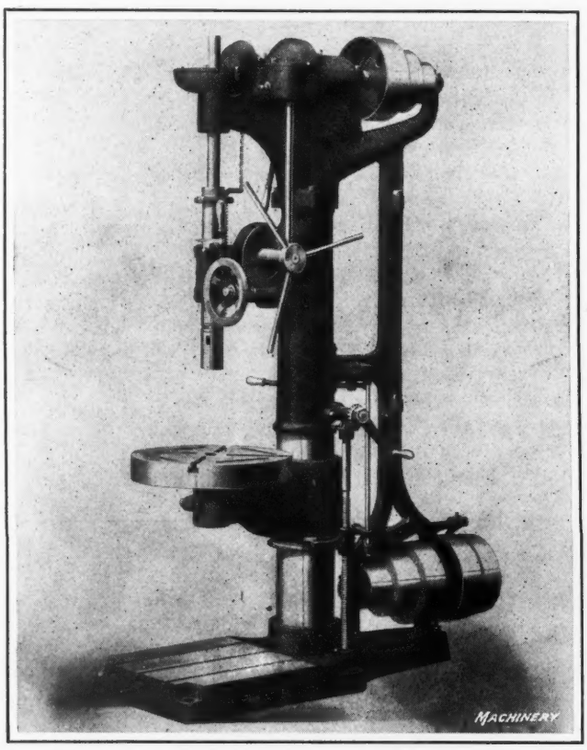
"Utility" Screw Press built by Carl Pletz & Sons

diameter of screw, but the No. 3½ machine will handle larger sizes of work. This press is adapted for straightening shafts, bars, rails, beams, etc.; and it is also arranged to force in or remove bushings, press gears or wheels on or off shafts and for the performance of forming operations on sheet metal. The bed is 4 feet long and heavily ribbed, with a hole cored under the screw to permit the work to drop through to the floor when it is pressed out. These cored holes also allow the pressing of pieces on or off long shafts.

The two upright posts are said to be strong enough to support ten times the load that will ever be applied to them in handling ordinary work. Steel is used in making the screw, and the threads are accurately chased to assure uniformity of operation. A steel pad fits on the end of the screw, and the thrust is taken on a hardened steel and bronze washer which is carried in a bath of oil. A handwheel on the end of the screw is fitted with a handle so that the screw may be quickly turned. By using a four-foot bar in conjunction with the handle, a pressure of twenty tons may be secured.

SIBLEY DRILLING MACHINE

In the December, 1919, number of MACHINERY, a description was published of a sliding-head drilling machine built by the Sibley Machine Co., 8 Tutt St., South Bend, Ind. This



Stationary-head Drilling Machine built by the Sibley Machine Co.

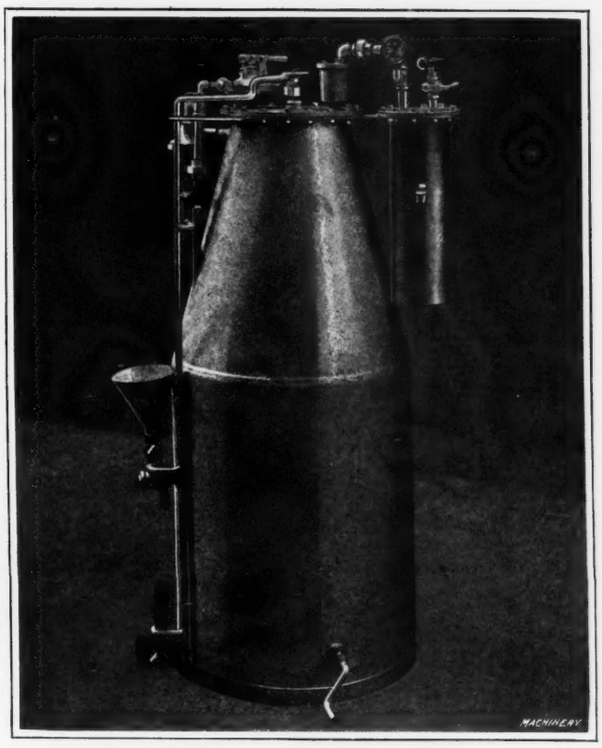
firm has recently added to its line a stationary-head machine, which is of quite similar design, with the exception that the sliding-head feature is not included. The fixed-head machine is built in 24-, 26-, and 28-inch sizes. The general features of its construction will be apparent from the accompanying illustration.

IMPERIAL AUTOMATIC ACETYLENE GENERATOR

For use in generating acetylene gas from calcium carbide and water for the performance of cutting and welding operations, etc., the Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago, Ill., has recently developed an automatic generator which is here illustrated and described. The most important feature of this equipment is the way in which

the mechanism has been simplified. It is stated that the carbide feed is simple and dependable, being automatically stopped when the torch is extinguished, and it starts automatically when the torch is relighted, thus maintaining a constant gas pressure. The Imperial automatic acetylene generator is of the medium pressure carbide-to-water type. Provision is made for feeding the carbide to the water by a device which is easily controlled. The feed mechanism and carbide hopper are fastened to the head of the machine, making it possible to remove all of the working parts by taking off the head of the generator.

Feeding is accomplished by a simple vibrator working on the dashpot principle with but one moving part. This vibrator is operated directly by the gas flowing through it from the generator into the torch. The pressure in the generator is controlled by the tension of a spring in a diaphragm governor. Interlocking safety levers make this generator absolutely fool-proof and compel users to follow the proper sequence of operations necessary to start or stop the generator. A dependable safety blowout makes it impossible to obtain more than 15 pounds pressure, which is recognized as the maximum for acetylene gas. The gas purifier has a water seal which cools the gas and absolutely prevents a flashback reaching the gas in the generator.

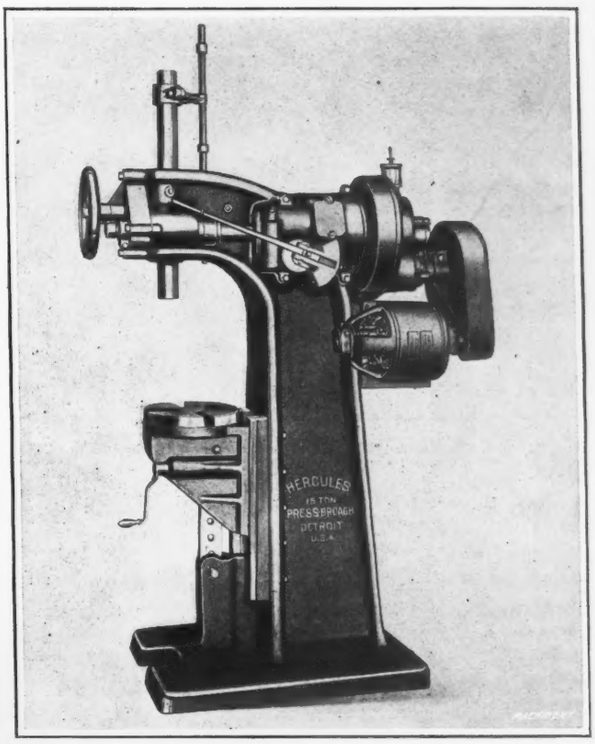


Automatic Acetylene Generator made by the Imperial Brass Mfg. Co.

Equipments of this type are built in 15-, 25-, 50-, and 100-pound sizes to afford a sufficient range to meet all service requirements.

IMPROVED HERCULES ARBOR PRESS

The Hercules Machinery Co., 110 Woodbridge St., Detroit, Mich., has recently made certain noteworthy improvements in the power-driven combination arbor press and broaching machine of its manufacture. These modifications of design are said not only to increase the efficiency of the machine, but also to add to the number of operations that it will handle. The machine only occupies six square feet of floor space and it has a ram travel of 18 inches with a vertical adjustment of 14 inches for the knee, making a total working distance of 32 inches. The knee is also removable, which permits the use of other fixtures; and on account of the



Power-driven Combination Arbor Press and Broaching Machine built by the Hercules Machinery Co.

open column design, this machine is said to be suitable for use on conveyor lines.

This machine has a rated capacity of 15 tons, but modifications of the design of the clutches and an increase of the gear ratio has made it possible to get as high as 20 tons gage pressure, and the machines are now being tested for 18 tons pressure. The design provides a shear pin in the main driving shaft that gives way at 18 tons to prevent danger of breaking parts of the machine. An automatic trip is furnished as regular equipment, which has the same effect as the automatic stop on a screw machine, and can be set to govern the travel of the ram. When so specified, all necessary equipment for the application of individual motor drive can also be furnished.

FACE GRINDING TABLE FOR BADGER GRINDER

The Badger Tool Co., Beloit, Wis., has recently developed a face grinding table for use on its single-spindle disk and cylinder-wheel grinders. Attention is called to the fact that

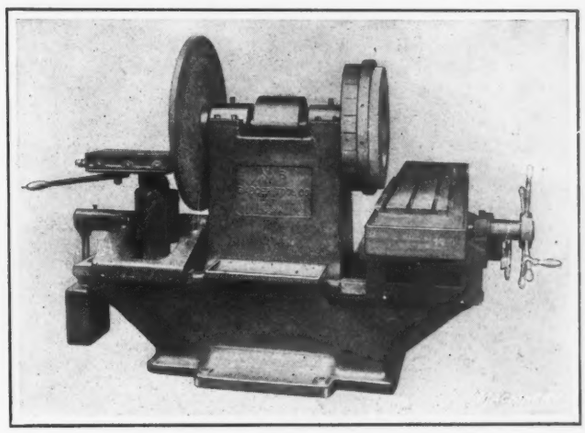


Fig. 1. No. 8 Grinder built by the Badger Tool Co., which is equipped with the New Face Grinding Table

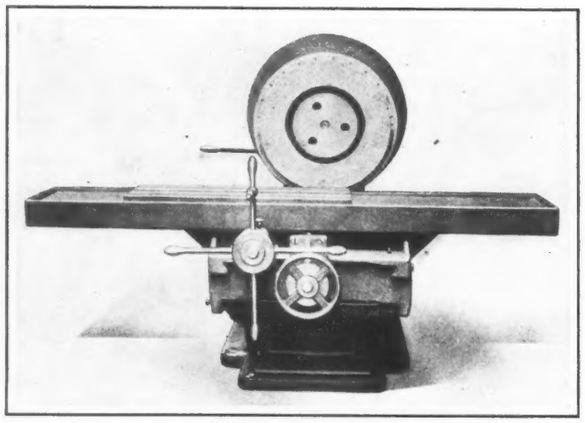
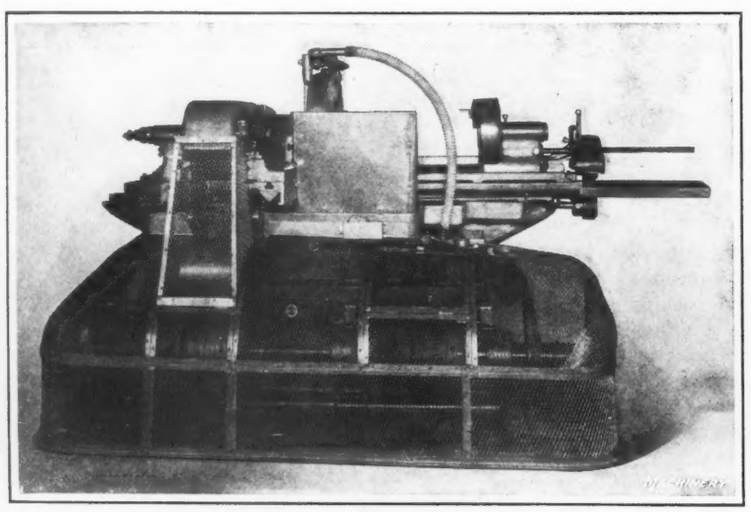


Fig. 2. End View of the No. 8 Badger Grinder illustrated in Fig. 1, showing Table in More Detail

the standard base for machines of this company's manufacture is well adapted for carrying a face grinding table of this type. The working surface of the table is 10 by 32 inches, and the longitudinal travel is 32 inches. Over-all dimensions of the table top are 14 by 73 inches, and travel is produced by means of a rack and pinion actuated by a handwheel with a leverage of 10 to 1. A graduated handwheel with a screw and nut affords a 4-inch feed movement toward the grinding wheel, and large adjustments can be made by moving the main saddle on the knee. As shown in the accompanying illustrations, this face grinding table serves a 20-inch abrasive cylinder held in a Badger chuck. The left-hand end of the spindle carries a 30-inch disk wheel and is served with one of this company's universal lever-feed tables. All table and grinding wheel equipments for use on Badger machines are interchangeable. Complete dust exhaust or wet grinding systems can be supplied; and the machines, all of which have ball bearing mounted spindles, can be furnished with either belt or individual motor drive.

GUARD FOR MODERN TOOL CO.'S GRINDER

Beginning August 1, practically all plain grinding machines built by the Modern Tool Co., Second and State Sts., Erie, Pa., will be furnished with a new phantom guard. This guard is a combination of expanded or perforated metal riveted to an angle-iron frame, giving both lightness and strength. It was first given a trial in the factory of the Modern Tool Co. Then a number of grinding machines were equipped with it and sent to other factories to ascertain their opinion. Such pleasing reports were received that the new type of guard was adopted as standard.



Guard for Plain Grinding Machines built by the Modern Tool Co.

The new guard is light and easily handled. It gives a practically complete view of all moving parts, and encloses all gears, pulleys, and belts. In this it efficiently meets the safety requirements of all state laws without extra expense. It saves space, as it permits machines to be set closer together. Instead of being square, all corners are rounded, and do not project into the passageways. Hinged portions and hand-holes make lubrication and minor adjustments easily accomplished without the necessity of removing the guard. This type of guard will not only permit all moving parts to be seen and watched, but it will act as a check against the accumulation of dirt. It can be placed in position or removed without the use of wrench or screwdriver. It is supplied as a unit, and not in sections which must be bolted or screwed together.

FEATURES OF CINCINNATI PLANERS

The following description explains certain improved features found on metal planing machines manufactured by the Cincinnati Planer Co., Cincinnati, Ohio. Machines built by this company are now furnished with a box type of arch, box type of cross-rail, and automatic stops for the cross-rail elevating and lowering device. The box type of arch is said to afford strength and rigidity to the housings and upper part of the machine. The tops of the housings have been widened to accommodate it and, as shown in Fig. 1, provision is made for securely bolting the arch in place at all four corners.

Fig. 1. Box Form of Arch now used on Metal Planing Machines built by the Cincinnati Planer Co.

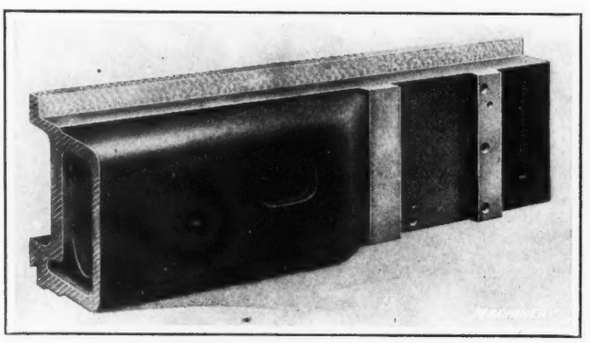


Fig. 2. Box Form of Cross-rail now used on Planing Machines built by the Cincinnati Planer Co.

The same form of construction has been employed for the cross-rail. As shown in Fig. 2, it is furnished with a deep and heavy box section which is well ribbed. This construction is said to add considerable rigidity and firmness to the cutting tools and to the machine in general. The automatic stops for the cross-rail elevating and lowering device, shown in Fig. 3, are another convenient feature. In operation, the elevating device is released by a horizontal movement of rod *D*

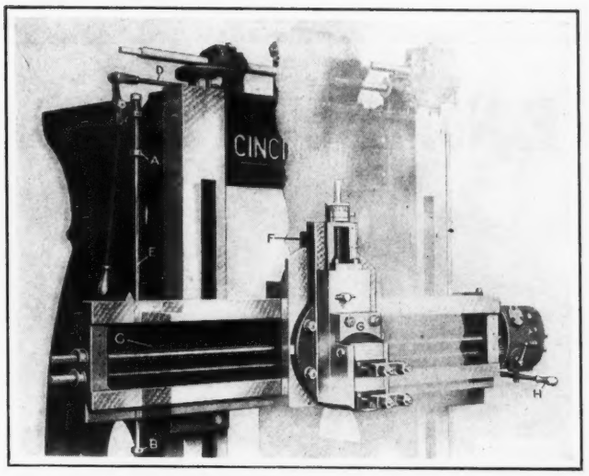


Fig. 3. Automatic Stops for the Rail Elevating and Lowering Device, New Style of Saddle for the Rail Head, Safety Clamp for Clapper-box, and Rapid Traverse for Rail Head

which is actuated by rod *E* moving in a vertical direction up or down, depending upon the direction of travel of the rail when bracket *C* comes into contact with stop-collar *A* or *B*. Stop-collar *A* remains in a fixed position on rod *E* at all times, but collar *B* is adjustable to stop the movement of the cross-rail in any position within its range of travel. In Fig. 3 there is also shown a new style of saddle which makes provision for clamping the upper part of the harp or swivel against the face of the saddle by means of a clamp *F*. Attention is also called to the clamp *G*, which prevents breakage of the clapper-box, and to the rapid power traverse mechanism *H* that provides for quickly moving the rail head into the required position.

GRANT AUTOMATIC CHAMFERING MACHINE

A double-spindle automatic chamfering machine has recently been developed by the Grant Mfg. & Machine Co., 90 Silliman Ave., Bridgeport, Conn. Machines of this type are built for different purposes, but the accompanying illustrations show one equipped for simultaneously chamfering both ends of automobile engine piston pins that are ⅝ inch in diameter by 3 inches in length. After being cut off from the bar or tube, these pins are placed in a hopper on the machine, from which they are taken by a slide and placed in the proper position to be clamped, while the cutters come in from each end and perform the chamfering operations. When the cutters recede, the clamp is released and the feeding slide, which has already brought another pin part way into position, pushes it forward and at the same time ejects the finished pin which comes down the slide at the left-hand side of the machine table. Pins of this size are chamfered at both ends at the rate of forty per minute. This type of machine is not restricted in its application to the chamfering of pins; it can also be used for a variety of other work where operations must be performed on opposite ends of a piece, such as drilling, counterboring, facing, etc. Neither is the work restricted to round pins, as square or irregular shaped pieces can be handled with equal facility.

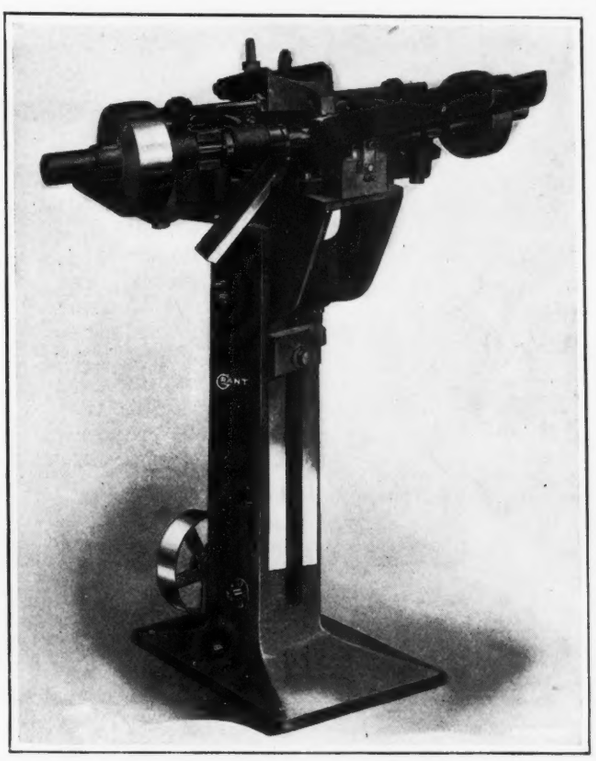


Fig. 1. Chamfering Machine built by the Grant Mfg. & Machine Co.

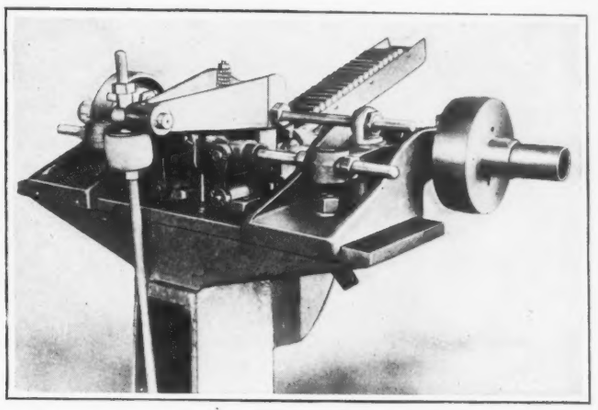


Fig. 2. Close-up View of Mechanism on the Grant Chamfering Machine

NEW MACHINERY AND TOOLS NOTES

Milling Attachment: Tri-State Milling Machine Co., Memphis, Tenn. A milling attachment for use on shapers. The spindle is worm-driven and is supported by a substantial over-arm. This attachment is adapted for mounting in the shaper ramway, the ram being moved back.

Bench Drilling Machine: G. R. Mellon, 933 Communipaw Ave., Jersey City, N. J. A bench drilling machine equipped with a turret work-rest, designed to accommodate pieces of different shapes. By pulling the table forward it is disengaged and can be turned to bring the desired form of work-rest into the working position.

Straightening Press, Arbor Press and Truing Machine: Detroit Garage Equipment Co., Detroit, Mich. A combination straightening press, arbor press, and truing up machine, which is adapted for use in service stations for straightening crankshafts, etc. The machine can also be used as a punch press or as a broaching machine.

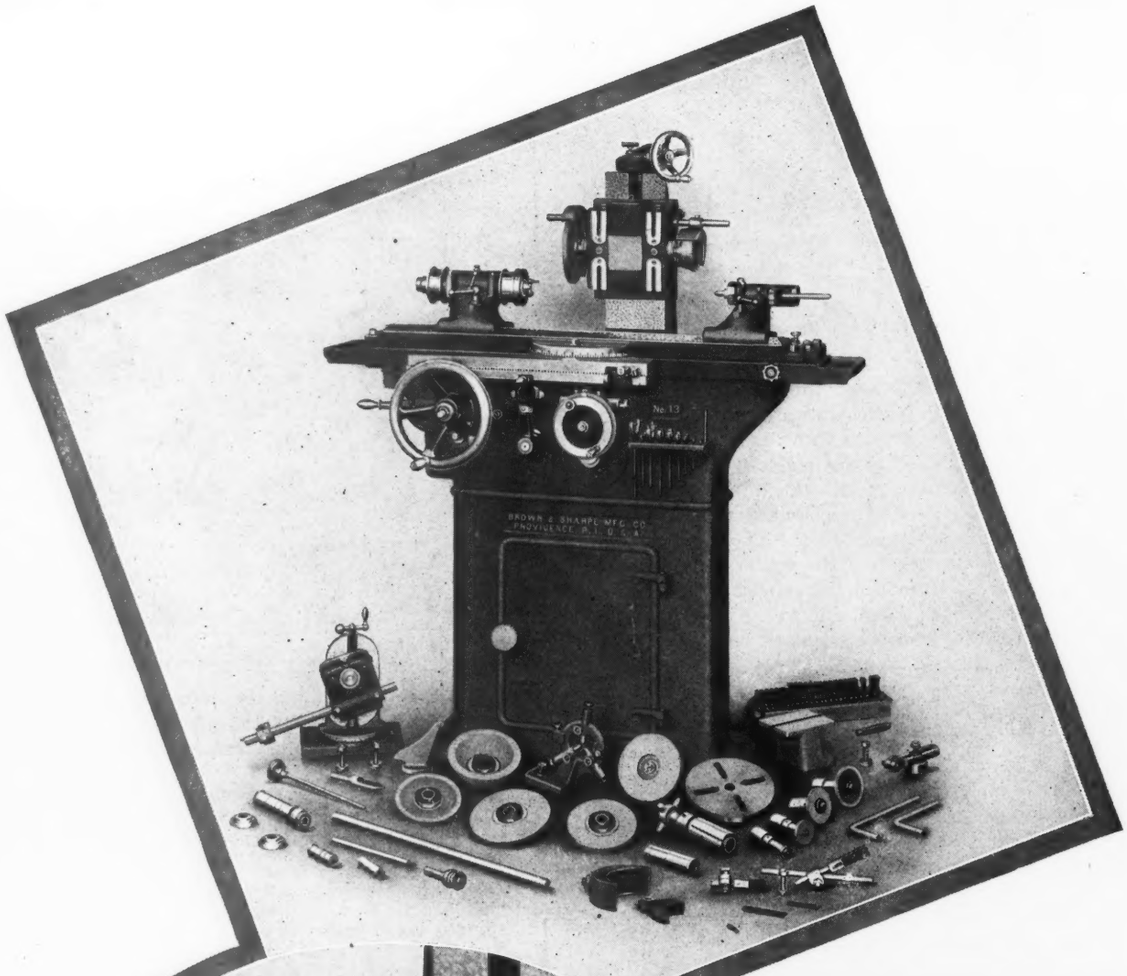
Anti-rust Compound: Conversion Products Corporation, 149 Broadway, New York City. An anti-rust compound known as "Stazon," which is an inert chemical grease derived from petroleum. It can be rubbed or brushed on the bright parts of machines destined for storage or shipment, and is said to be proof against acid fumes or moisture.

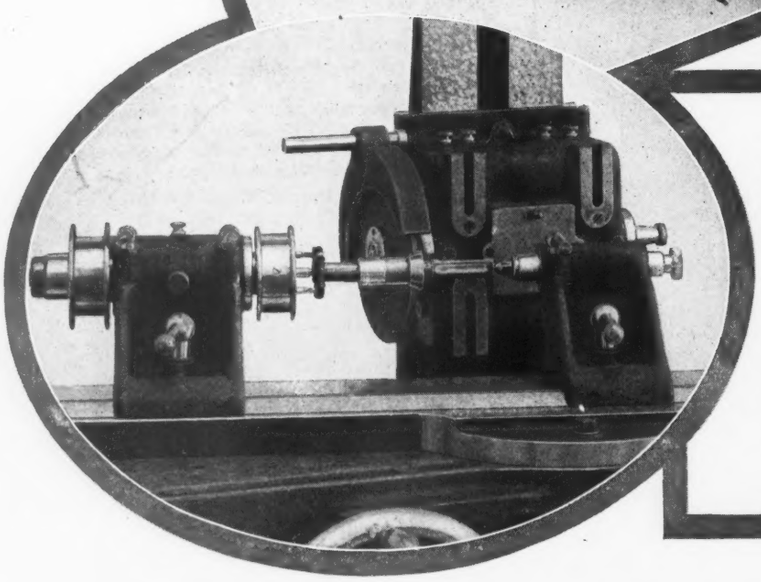
Crankshaft Straightening Presses: Metalwood Mfg. Co., Detroit, Mich. A line of hydraulic power presses for straightening drop-forged automobile engine crankshafts. Several types of these machines are made in sizes ranging from 20 to 65 tons working pressure, and with table lengths suitable for the work on which each machine is to be used.

Machine Tool Centers: Eastern Tube & Tool Co., Inc., 594 Johnson Ave., Brooklyn, N. Y. A device known as the "Ettco" inserted center, which has a shank tapered to fit the spindle and an inserted center which is made of high-speed steel and threaded into the carbon steel shank. These centers are furnished in various standard sizes and tapers.

Tool Rack: International Purchasing Bureau, 203 E. 15th St., New York City. A convenient type of tool rack furnished with trays made of cast iron and arranged to swivel about a central support. There are four trays, three of which are

BROWN & SHARPE No. 13 UNIVERSAL

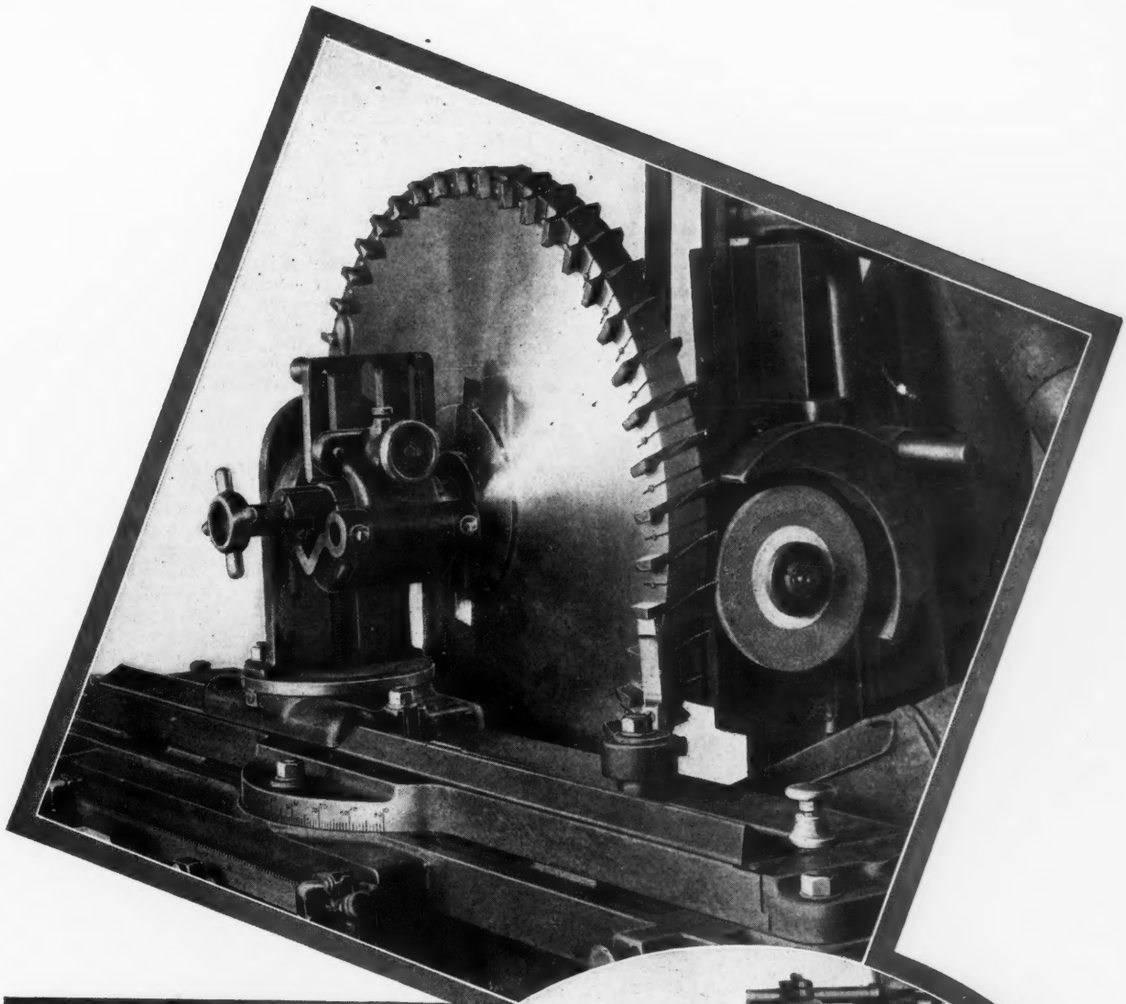




For the shop whose needs call for the grinding of a large variety of work the No. 13 Universal and Tool Grinding Machine is particularly valuable, especially where the volume of grinding does not warrant the installation of different machines for each kind of work.

BROWN & SHARPE MFG. CO.,

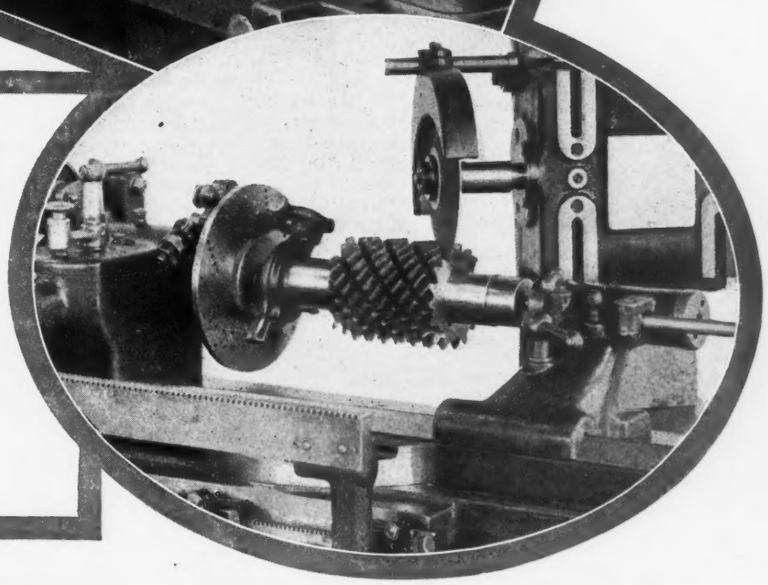
and TOOL GRINDING MACHINE



The No. 13 Universal and Tool Grinding Machine can be used to advantage in the grinding of

Milling Cutters
Formed Cutters, Hobs
Straddle and face mills
Beveled Cutters—any angle
Straight or taper reamers,
as well as
Cylindrical
Internal
Surface
Straight or taper work.

Write for specifications



PROVIDENCE, R. I., U. S. A.

intended for holding tools or pieces of work, while the small tray at the top is adapted for holding micrometers and other fine tools.

Electric Lamp: Cooper-Hewitt Electric Co., 8th and Grand Sts., Hoboken, N. J. A new type of auxiliary for use in connection with alternating-current lighting units, which has made it possible to raise the power factor of lamps from 52 to 85 per cent.

Bench Drilling Machine: Van Dorn Electric Tool Co., Cleveland, Ohio. This machine consists of a portable electric drilling machine, which is mounted on a stand provided with a movable head to support the electric drill and a fixed table on which the work is held.

Two-spot Welding Machine: Federal Machine & Welder Co., Dana Ave., Warren, Ohio. A rotatable-head two-spot air-operated welding machine, with a 60-inch throat depth, which is guaranteed to weld from two thicknesses of twenty-four-gage up to two thicknesses of eight-gage steel stock.

Bench Vise: V. Lowener, 114 Liberty St., New York City. A vise made by Soderfors Bruks, Falun, Sweden, and sold in this country by V. Lowener. This is known as an all-steel vise, the parts being made of Dannemora alloy steel which is said to be stronger and tougher than chisel steel.

Spot Welding Machine: Federal Machine & Welder Co., Dana Ave., Warren, Ohio. An automatic spot welding machine for operation on channels, that provides for securing two channels together to form an I-beam. This machine is capable of welding two spots at a time on two pieces of material ¼ inch in thickness.

Keyseating Machine: Hercules Mfg. Co., Portland, Ore. A keyseating machine consisting of a cross-head driven through a rack and pinion. By means of a wood-covered friction disk operating between the two driving pulleys, which run in opposite directions, reversal of motion is accomplished, and it is claimed that a very smooth action is secured.

Portable Electric Drilling Machine: Electro-Magnetic Tool Co., 2902 Carroll Ave., Chicago, Ill. A portable electric drilling machine which has a handle of the pistol grip type. The motor is series-wound, fan-cooled, and operates on voltages either 10 per cent above or below normal. Adjustable ball bearings support the armature shaft, and a ball thrust bearing takes the end load of the spindle.

Duplex Drilling Machines: Moline Machinery Co., Moline, Ill. A line of duplex drilling machines designed to afford rapid production. Details of these machines differ considerably to adapt them for handling a variety of drilling operations. The line includes machines equipped with both hand and power feed, and with the spindles either opposed or arranged to feed in the same direction.

Tiering Truck: Karry-Lode Industrial Truck Co., Long Island City, N. Y. A lifting and tiering truck intended for use over smooth level floors. This truck has a lifting capacity of 4000 pounds at the rate of 3 feet per minute, and it will deliver its load 65 inches above the floor. The platform measures 26 by 54 inches in size, and when in its lowest position it is 11 inches above the floor.

Electric Furnaces: General Electric Co., Schenectady, N. Y. Electric heat-treating furnaces of the resistance type for use in hardening automobile gears, pinions, etc. Similar furnaces are made for use in the performance of carburizing, annealing, and drawing operations. Energy is furnished by three-phase, sixty-cycle, 220-volt alternating current, and the furnaces have a capacity of 60 kilowatts.

Bench Horn Press: Enterprise Machinery Co., 32 S. Clinton St., Chicago, Ill. A machine known as the Type V "Emco" bench horn press which is adapted for rapid production in the assembling of small parts and for the performance of such operations as seaming or riveting on hollow work. The machine is made with strokes of ¾, 1¼, and 1¾ inches; it runs at 300 revolutions per minute and weighs 130 pounds.

Pumpless Blow-torch: Pumpless Blow-torch Co., Phipps Power Bldg., Pittsburg, Pa. A blow-torch which does not require preliminary pumping and preheating. The fuel used is butane, which is obtained from natural gas and reduced by pressure to a liquid condition. This liquid volatilizes in the fuel chamber of the torch, filling the space between the surface of the liquid and the top of the chamber with gas.

Slotting Machine: Newton Machine Tool Works, Inc., Twenty-third and Vine Sts., Philadelphia, Pa. A large portable slotting machine, which consists of an upright mounted on a sub-base and carrying a tool suitably mounted on a saddle that reciprocates vertically. The saddle has a maximum stroke of 76 inches, and the tool-slide has a cross-feed of 40 inches and an in-and-out feed of 6 inches, both actuated by power.

Pipe and Fitting Wrench: J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. A tool known as the "Falcon" wrench, which has a wide range of applications, being particularly suited for use on pipe and pipe fittings. The wrench has a curved serrated jaw and a chain that extends around the pipe or fitting, so that when the handle of the wrench is pulled, the curved jaw swings inward to enable the serrations to secure a firm grip.

Universal Plate Mill: MacKintosh, Hemphill & Co., Pittsburg, Pa. A 27-inch by 40-inch reversing universal plate mill built for use in the plant of the Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada. This mill will roll plates from a minimum width of 6 inches up to 40 inches. The top and bottom rolls are 27 inches in diameter with a lift to the top roll of 20 inches, while the vertical rolls are 18½ inches in diameter.

Pneumatic Drilling Machine: Turbine Air Tool Co., 710 Huron Road, Cleveland, Ohio. A portable pneumatic drilling machine built on the turbine principle, which is known as the "Turbine Jr." drill. It is designed for drilling and reaming holes ½ inch in diameter through metal or for boring holes 1 inch in diameter in wood. The tool is of simple design, consisting of only fifteen primary parts and four parts that are subject to wear. The weight is 9 pounds.

Crankshaft Milling Machine: William K. Stamets, Pittsburg, Pa. For machining the outside or periphery of the webs of crankshafts of the counterbalanced type, grinding and polishing do not always produce sufficiently accurate results, and it was to meet the requirements of this work that the present machine was designed and built. The job is practically a cam-cutting operation, the desired form for the work being obtained by masters of the required shape.

Screw Meter: Selson Engineering Co., 24 Stone St., New York City. An apparatus made by Andrew Bechler, Moutier, Switzerland, and sold by the Selson Engineering Co. It enables the nominal diameter, the pitch diameter, and the root diameter of screw threads to be measured to 0.01 millimeter or 0.00025 inch. The screw meter is furnished in two models, one of which is adapted for gaging screws from 1 to 80 millimeters in diameter, while the other is for measuring screws from 1 to 25 millimeters in diameter.

Inclinable Power Bench Press: La Salle Machine Works, 3013 S. La Salle St., Chicago, Ill. A machine known as a No. 0 "Verson" inclinable power bench press which is said to be adapted for the use of jewelers, electrical brass workers, and manufacturers of various novelties. The press has a stroke of 1 inch and an adjustment of 1 inch, and the distance from the bed to the slide with the stroke down and adjustment up is 5 inches. A No. 00 non-inclinable machine is also built by this company. Both of these machines can be furnished with a table and legs, if so desired.

Boring Tool: Expansion Boring Tool Co., 290 Rivard St., Detroit, Mich. A two-point expansion boring tool, designed to afford a wide range of expansion to the cutters, in addition to ample strength for handling heavy work. Another feature is the ample chip clearance that is afforded. Expansion of the cutters is accomplished by means of a right- and left-hand screw which forces the cutters out to the desired boring diameter and prevents them from working out to bore a larger diameter than is required. Tools of this type are made for boring holes from 1 to 8.81 inches in diameter.

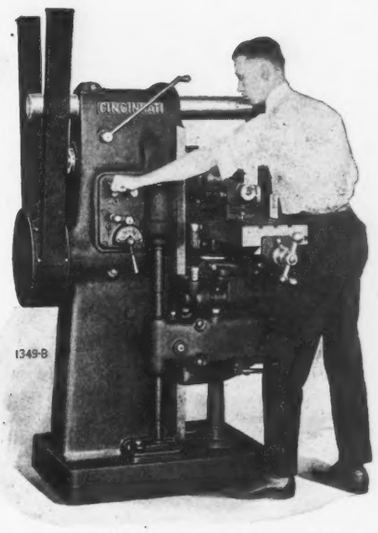
Oxy-hydrocarbon Burner: Berg Burner Co., Inc., 100 Emerson Place, Brooklyn, N. Y. A device known as the Berg burner, designed to use oxy-hydrocarbon gas, which it automatically produces from oil and water. Superheated steam is generated by the burner and combined with the oil flow as it leaves the nozzle. The hydrogen of the steam unites with the hydrogen and carbon of the oil, setting free oxygen in a superheated state, which is said to create perfect combustion. This burner may be started with cold water by burning oil in a preheating dish provided for that purpose.

Duplex Slot Milling Machine: Garvin Machine Co., Spring and Varick Sts., New York City. A No. 3 duplex milling machine especially adapted for use in railroad shops for machining such parts as cross-heads, piston-rods, etc., which must be slotted to receive tapered keys. Both sides of a slot are milled simultaneously by this machine, the work reciprocating while the cutters are fed inward intermittently. For milling a slot entirely through a piece, one cutter recedes automatically upon reaching the center of the work, and the other continues to advance, thus removing metal from the center of the work.

Milling and Grinding Attachment: Eccles & Smith Co., San Francisco, Cal. A milling and grinding attachment consisting of a vertical column carrying a saddle that has either a milling or grinding quill supported on it. A motor-driven countershaft suspended from a trolley rail, a driving wheel, an indexing mechanism, and an auxiliary countershaft form the other important parts of this device. It is attached to the tool-rest of a lathe by means of a central bolt through the column, and the saddle can be raised or lowered by a micrometer screw or it can be rotated around the column to any desired position.

Without Leaving His Position

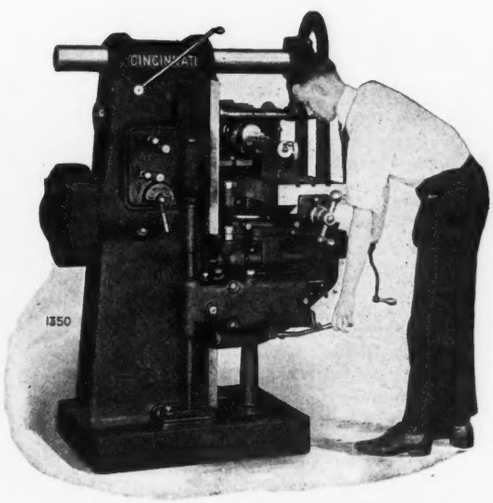
The operator can start the machine—
Change the feeds—
Change the speeds—and
Stop the machine—
When working on



The operator can usually reach the speed change levers without leaving his position. The belt is guarded 6 feet above the floor. This meets the usual factory safety requirements.

Plain, Universal or Vertical

CINCINNATI
M-TYPE MILLERS



Feed changes are all made at the front of the machine from the operator's normal position.

They are handy, compact, durable machines with unusual strength and power for their size.

ASK US FOR COMPLETE DETAILS GIVEN IN THE 1920-M CATALOG

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U.S.A.

NEW BOOK ON SHOP MATHEMATICS

SHOP MATHEMATICS. By Erik Oberg and Franklin D. Jones. 280 pages, 6 by 9 inches; 109 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $3.

This book has been published primarily for machinists and toolmakers, and for students interested in what is commonly known as "shop mathematics." The object of the book is to explain and illustrate, by numerous examples, the different kinds of problems which are commonly encountered in the construction of machinery and tools. The selection of the subjects treated is based on a careful study of the problems which are of the greatest practical value and often the most perplexing to the average shop man. The men whose training has been confined largely to the machine shop and toolroom often find it difficult to apply mathematical theories to shop problems. Because of this fact, most of the examples in this book are taken directly from the shop, and they have been largely selected from problems which shop men have repeatedly submitted for solution; but other examples have also been included in order that a somewhat broader field might be covered and important principles explained. Numerous examples are given so that the method of actually applying a rule or formula will be entirely clear.

Many of the more elementary subjects, such as addition, multiplication, division, etc., have been omitted, as practically all skilled men and most apprentices possess this rudimentary knowledge; but, in view of the fact that calculating is not a regular part of the shop man's work and he is liable to become "rusty" even in some of the simpler branches of arithmetic, a few elementary subjects which often prove "stumbling blocks" have been included, such, for example, as the multiplication and division of common and decimal fractions, proportion, square and cube root, and percentage.

While drawings should be so complete that calculations in the shop or tool-room are, as a general rule, unnecessary, in small shops, and sometimes in connection with special work, the machinist or toolmaker often finds it desirable to solve his own problems; and even though mathematics is not applied directly to the work of the shop, a knowledge of this subject will usually greatly assist the man who desires to advance. In fact, many excellent designers, as well as foremen and superintendents, are shop graduates who studied mathematics. This book, therefore, is intended not only to assist the reader in the solution of the problems liable to arise in everyday shop practice, but to lay the foundation for obtaining a higher position in manufacturing and engineering practice.

The book is divided into seventeen chapters, headed as follows: Value of Mathematics to Machinists and Toolmakers; Arithmetic Commonly Used in Shop Problems; What Formulas are and how they are Used; How to Calculate Areas of Plane Surfaces; How to Calculate Volumes, Weights, and Capacities; Figuring Tapers; Speeds of Pulleys and Gearing; Calculating Cutting Speeds, Feeds, and Machining Time; Change-gearing for Thread Cutting and Spiral Milling; Angles and the Use of Tables when Figuring Angles; Solution of Right-angled Triangles; Solution of Oblique-angled Triangles; Milling Machine Indexing; Calculations for Cutting Gears; Typical Machine Shop Problems; Examples in Elementary Mechanics; and the Use of Diagrams.

PERSONALS

R. B. HUBBELL, formerly assistant sales manager of the Heald Machine Co., Worcester, Mass., has been appointed sales manager of Churchill-Morgan-Crittsinger, Inc., Worcester.

JAMES T. LEE has become a member of the sales engineering staff of the Southwark Foundry & Machine Co., Philadelphia, Pa. For several years Mr. Lee was vice-president in charge of sales of the Hanna Engineering Works, Chicago, Ill.

DONALD S. MICHELSEN, formerly general manager of the Worcester Pressed Steel Co., Worcester, Mass., is now general manager of the Globe Machine & Stamping Co., Cleveland, Ohio. A. F. SCHROEDER, who has been general manager of the company for almost twenty years, will continue to hold the office of president.

EDWARD O. GOSS has been elected president of the Scovill Mfg. Co., Waterbury, Conn., to fill the place made vacant by the resignation of MARK L. SPERRY. Mr. Goss will also retain the general managership of the concern. Mr. Sperry has been associated with the company for fifty-eight years, and is now retiring entirely from active business affairs.

W. J. FULLER, formerly with Alfred Herbert, Ltd., Coventry, England, is now associated with Harper Bean, Ltd., of London, manufacturer of motor vehicles of all types. Mr. Fuller will be located in the National Association Building, 23 W. 43rd St., New York City, and will look after the interests of the company in the United States and Canada.

R. T. HAZELTON has been appointed works manager of the Cincinnati Shaper Co., Cincinnati, Ohio. Mr. Hazelton had been for several years past superintendent and chief engineer of the Cincinnati Milling Machine Co. In his new position, he will also have charge of production for the Cincinnati Gear Cutting Machine Co., which is a subsidiary of the Cincinnati Shaper Co.

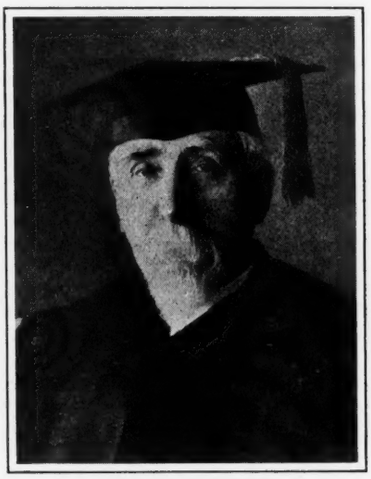
OLIN H. LANDRETH, who until recently has been chief engineer of the Eastern Potash Corporation, New Brunswick, N. J., has been appointed consulting engineer of the company. As his duties in that capacity will require only a portion of his time, Mr. Landreth expects to devote the remainder of his time to general consulting engineering work, specializing in power development, industrial engineering, hydraulic engineering, and valuation work.

ARTHUR JACKSON, who was formerly associated with the Gould-Shapley & Muir Co., Brantford, Ontario, Canada, and who was also connected with the Jones & Lamson Machine Co. of Springfield, Vt., selling and demonstrating Gridley automatics in Great Britain for the last five years, has been appointed Potter & Johnston representative with the Yamatake Co. of Tokyo, Japan, which is the Japanese agent of the Potter & Johnston Machine Co., Pawtucket, R. I.

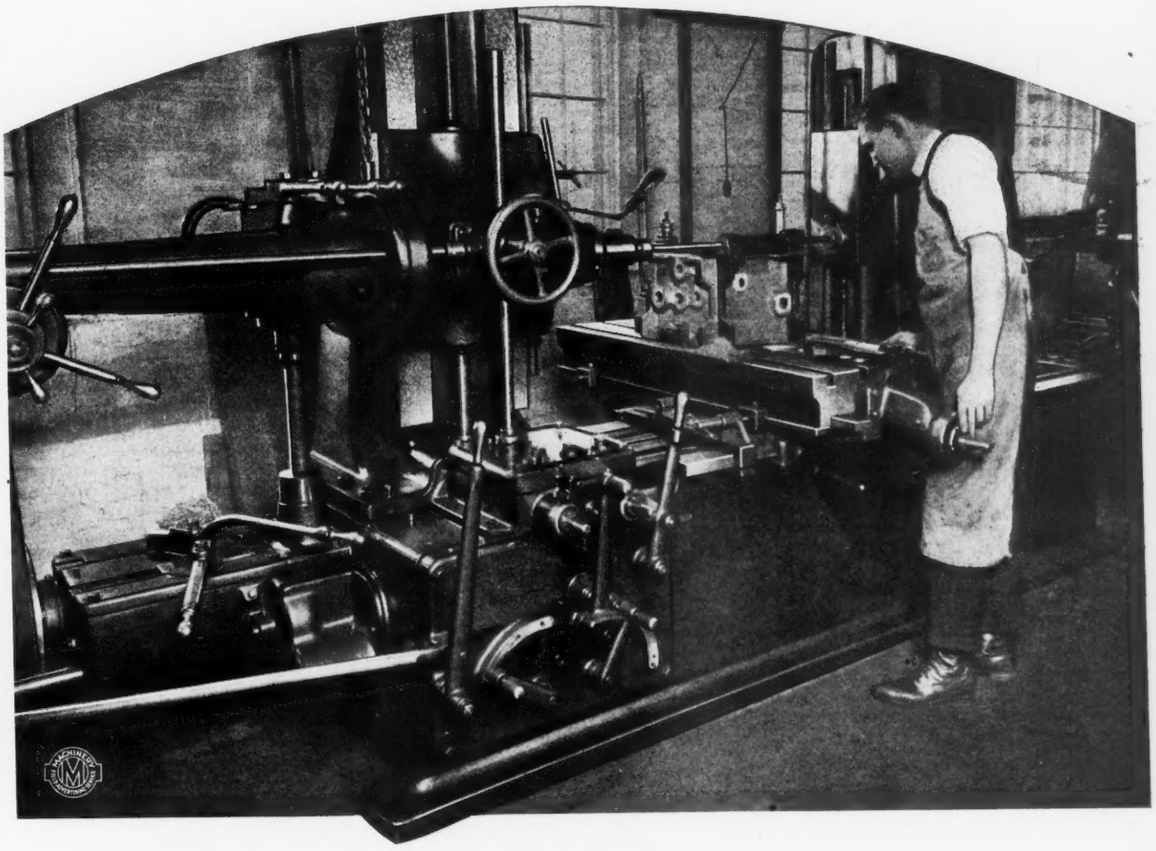
CHARLES EISLER has entered the consulting engineering field, and is devoting his time to designing and developing special and automatic machines for the manufacture of standard, miniature, and gas-filled lamps. The organization will also maintain a department for manufacturing wire product used in incandescent lamps. A temporary office has been established at 159 Clifton Ave., Newark, N. J.

HENRY M. LELAND RECEIVES DEGREE OF DOCTOR OF ENGINEERING

HENRY M. LELAND, president of the Lincoln Motor Co., Detroit, Mich., has had the degree of Doctor of Engineering, conferred upon him by the University of Michigan. In conferring this degree upon Mr. Leland, who has been called the father of the Detroit automobile industry, President Hutchins of the University of Michigan characterized his achievements in the following words: "A son of New England, but for thirty years a resident of this commonwealth, Mr. Leland brought with him the sterling virtues characteristic of early New England life, and has been a dynamic influence in the industrial development of his adopted state and a distinguished leader in movements for civic betterment. Always standing for the highest ideals, he has made a record in the field of mechanical science as applied to manufacturing development that has brought to him not only local and national, but also foreign recognition."



After having received his early mechanical training nearly sixty years ago and having worked in plants in New England that have since become famous the world over, Mr. Leland came to Detroit thirty years ago, where he engaged in the manufacture of precision machinery and tools. In 1902 he founded the Cadillac Automobile Co. together with Wilfred C. Leland and several prominent Detroit business men. He remained the active head of this concern until July, 1917, when he organized the Lincoln Motor Co. for the purpose of building "Liberty" aircraft motors. Although this company, when organized, had nothing in the way of plant or equipment, it was awarded the first government contract for the building of "Liberty" motors, and seven months later the first motor was assembled in a plant erected and equipped in record time for this work. After the armistice, the company set out to develop an automobile incorporating many new ideas, which is expected to appear soon.



Pratt & Whitney's Boring Machine Equipment Consists Principally of

LUCAS "PRECISION"
Boring, Milling and Drilling Machines

The accompanying photo, which was taken in the tool department of the P. & W. plant, shows a Lucas "Precision" Boring Machine engaged in locating and boring 21 holes, from 9/16″ to 2¼″ diameter, in a box drill jig. Distances from center to center, in this instance, are held within 0.001″ limits; but when necessary a skilled operator makes this machine perform this same class of operation within limits of 0.0002″.

There are seven of these machines in a row in the P. & W. toolroom—all devoted exclusively to manufacturing tools and jigs. Another row in the manufacturing department is an important factor in obtaining the accuracy for which P. & W. tools have long been famous.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich, Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

COMING EVENTS

September 14-18—Second annual convention and exhibit of the American Steel Treaters' Society of Chicago, Ill., and the Steel Treating Research Society of Detroit, Mich., in the Commercial Museum, Philadelphia, Pa. Department of Exhibits, 208 N. Wabash Ave., Chicago, Ill.

September 20-October 9—Sixteenth annual convention of the International Association of Machinists, at Rochester, N. Y.

October 4-9—Convention and exhibit of American Foundrymen's Association at Columbus, Ohio.

December 2-3—Nineteenth annual convention of the National Machine Tool Builders' Association in New York City; headquarters, Hotel Astor. General Manager, Charles E. Hildreth, Worcester, Mass.

December 7-10—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

BOOKS AND PAMPHLETS

Standard Electrical Dictionary. By T. O'Conor Sloane and A. E. Watson. 767 pages, 5 by 7 inches; 477 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $5.

This book, a new edition of which has just been published, is a complete dictionary of electrical terms, containing definitions and descriptions, with illustrations, of electrical appliances and connections, as well as material relating to electrical theory, experimentation, and engineering. It includes 6000 distinct words or phrases. The plan is to give first a concise definition and then amplify and explain more fully. The material is arranged in two parts, the second part being in the nature of a supplement comprising over 180 pages covering the newer developments of electrical science. This arrangement is rather a drawback, as it is necessary for the user to refer to both parts of the dictionary for the term he wants.

Screw Thread Production to Close Limits. By Howard E. Adt. 192 pages, 6 by 9 inches. Published by the Geometric Tool Co., New Haven, Conn.

This treatise, by a well-known authority on screw thread production, contains in condensed form considerable information and data pertaining to the different kinds of threads, thread tolerances, thread measurement, and the production of screw threads by means of taps and dies. In the first two chapters the evolution of the screw thread and the different standards are dealt with. Then follows information on such important subjects as limits and tolerances (accompanied by numerous charts and tables); gaging devices; definitions and symbols; testing threads for accuracy; checking thread gages; threading with dies; screw cutting on automatics; special threading requirements; taper threading die-heads; adjustable collapsing taps; combination collapsing pipe taps and reamers; accurate production of brass parts; cutting speeds; cooling lubricants; screw-thread cutting terms; method of forming dies, etc. The latter part of the book contains a chapter on the "Lessons of Experience." This chapter deals, in a very specific manner, with miscellaneous threading troubles and their remedies. The book is illustrated by both line and halftone engravings, and is well arranged for reference purposes.

Tin, Sheet-iron, and Copper-plate Worker. By Leroy J. Blinn. 334 pages, 5 by 7¾ inches; 207 illustrations. Published by Henry Carey Baird & Co., Inc., 2 W 45th St., New York City. Price, $3, net.

This volume is a new and enlarged edition of a book on sheet-metal working. It contains rules for describing various kinds of patterns used by tin, sheet-iron and copper-plate workers, and much miscellaneous material relating to this class of work. The problems on pattern cutting have been supplemented by problems dealing with triangulation and skylight work, and many other new pattern problems have been added. The portion of the book treating of metallic alloys and solders has been rewritten for the purpose of presenting a more systematic arrangement and to include modern practice in this field. New material has been added in all the other departments. An idea of the contents will be obtained from the following list of chapter heads: Rules for Describing Patterns; Practical Geometry; Mensuration of Surfaces; Mensuration of Solids and Capacities of Bodies; Table of Weights, etc.; Tables of the Circumference of Circles to the Nearest Fraction of Practical Measurement; also, Areas of Circles, in Inches and Decimal Parts, and in Feet and Decimal Parts; Practical Receipts; Varnishes—Miscellaneous; Lacquers; Miscellaneous Cements; Important Metallic Alloys; Miscellaneous Receipts; Strength of Materials; Tables of Strength of Materials; Supplementary Pattern Problems.

Experimental Wireless Stations. By Philip E. Edelman. 392 pages, 5 by 7 inches; 167 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

The material in the 1920 edition of this book has been revised and expanded. The subject matter covers the theory, design, construction, and operation of experimental wireless stations including wireless telephony, vacuum tube, and quenched spark systems. The readers are assumed to have some knowledge of the fundamentals of electricity and mathematics. The basic principles of radio-communication, involving the theory and mathematics of the subject, are given in considerable detail. The material is divided into twenty-seven chapters headed as follows: Nature of Wireless Transmission; Aerials; Coil and Subsurface Systems; Grounds and Lightning Protection; The Transmitter and Resonance; Wave Length, Capacity, and Oscillation Circuits; Transformers and Spark Coils Construction Details; Auxiliary Apparatus; Condensers and Capacities; Inductances; Spark Gaps; Radiation Indicators and Measurements; Advanced Systems; Vacuum Valves and Circuits; Tube Radio-telephones; the Receiving Station; Detectors; Sensitive Indicators for Receiving Sets; Tuning and Interference Prevention; Special Receiving Sets; Receiving Condensers; Construction of Receiving Inductances; Making the Wireless Set Work; Miscellaneous Applications; Time and Weather Signals; Radio-communication Patents; and Rights of the Experimenter.

Vocational Arithmetic. By Clarence E. Paddock and Edward E. Holton. 232 pages, 5 by 7 inches; 83 diagrams. Published by D. Appleton & Co., 35 W. 32nd St., New York City. Price, $2, net.

This is an elementary book on arithmetic, written for the use of students in vocational schools and men in the shop. The volume is said to be the result of years of vocational teaching on the part of the authors, supplemented by extensive shop and engineering practice. The usual branches of arithmetic are treated in a simple way, and a large number of problems are given. These problems have been selected with a view to making them of interest and use to persons in various lines of work such as shop work, carpentry, foundry work, masonry, and excavation. The authors have striven to express themselves in simple and clear language without sacrificing exactness. The contents are as follows: Signs, Symbols and Abbreviations; Notation; Addition; Subtraction; Multiplication; Division; Properties of Numbers; Greatest Common Divisor; Least Common Multiple; Cancellation; Common Fractions; Decimal Fractions; Percentage; Commercial Discount; Interest; Compound or Denominate Numbers; Ratio and Proportion; Powers and Roots; Square Root; Cube Root; Use of Formulas; Mensuration, Plane; Mensuration, Solid; Similar Surfaces and Soils; Bolts and Nuts; Excavations; Masonry; Measurement of Lumber; Matched Boards; Boxes and Packing Cases; Shingles; Pattern and Foundry Work; Speeds of Pulleys and Gears; Toothed Wheels; Tables of Weights and Measures; Weights of Materials; and Metric System.

Shop Practice for Home Mechanics. By Raymond Francis Yates. 314 pages, 6 by 9 inches; 309 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

This book has been written especially for the use of amateurs or home mechanics, and treats in an elementary way of the use of tools, shop processes, and the construction of small machines. The author states that an examination of current volumes on shop practice has shown nothing especially adapted for the use of amateurs, and his aim in writing the present volume has been to fill this need. The subject matter has been arranged progressively, so that the beginner can study the book just as he would a book on elementary chemistry, for instance. The first chapter treats of the fundamentals upon which the science of mechanics rests, and the following chapters take up simple shop operations and the use of small tools. Considerable space is given to the lathe, as this is considered the most important tool to the home mechanic, without which little can be done in the way of serious work. Such operations as grinding, hardening and tempering steel, patternmaking, soldering, etc., are included. The book is divided into fourteen chapters headed as follows: Introduction to the Study of Elementary Mechanics; The Use of Miscellaneous Tools; Measuring Instruments and Their Use; Drilling and Reaming; Introduction to Lathe Work; Advanced Lathe Work; Special Lathe Work; Grinding Operations; Patternmaking; Hardening and Tempering Steel; Soldering and Brazing; Construction of Small Power-driven Press; Construction of a Small Grinding Head; and General Information.

NEW CATALOGUES AND CIRCULARS

U. S. Gutta Percha Paint Co., Providence, R. I. Circular advertising "Barreled Sunlight," a rice process mill white paint which is claimed to be non-scaling.

Link-Belt Co., W. Michigan St. and Holmes Ave., Indianapolis, Ind. Circular entitled "The Stars of Motordom," advertising the use of Link-Belt silent chain for motor front-end drives.

J. B. Engineering Co., Akron, Ohio. Sheets known as "Dope Sheets," containing information regarding the speeds, feeds, and general dimensions of important parts of standard machine tools.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 1002, illustrating and describing Hisey-Wolf motor-driven ball-bearing buffing and polishing machines, made for use with either direct or alternating current.

Metalwood Mfg. Co., Detroit, Mich. Circular B 23 descriptive of Metalwood universal hydraulic arbor and forcing presses of the A type, which are made in three sizes with capacities of 35, 60, and 100 tons, respectively.

Avey Drilling Machine Co., Inc., Cincinnati, Ohio. Catalogue illustrating and giving complete specifications for the Avey line of high-speed ball bearing sensitive drilling machines, which are built in combinations of one to six spindles, with hand or power feed.

La Salle Machine Works, 3013 S. La Salle St., Chicago, Ill. Circular descriptive of the Verson bench power press, adapted for light and accurate manufacturing, including such operations as blanking, forming, bending, trimming, punching, perforating, printing, and cutting.

Cleveland Twist Drill Co., Cleveland, Ohio. Circular entitled "Two New Official World's Speed Records," containing an account of the performance of Cleveland twist drills in drilling through 6 feet of cast iron in 60 seconds, and through 2½ feet of machine steel in 60 seconds.

Whipp Machine Tool Co., Sidney, Ohio. Bulletins 20 and 22, illustrating and describing, respectively, Whipp 16-inch crank shapers of the single-geared and back-geared type. Form 23, giving specifications for Whipp 16- and 20-inch single- and back-geared crank shapers.

Hyatt Roller Bearing Co., Sixth Ave. and 41st St., New York City. Circular illustrating the application of Hyatt roller bearings in tractors and farm implements, motor cars and trucks, mine cars and mining machinery, factory and warehouse trucks and steel mill machinery.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Circular illustrating applications of Shepard electric hoists of the cage-controlled and floor-controlled types, for handling loads of 500 pounds or less and 25 tons or more, as well as of electric traveling cranes in capacities of from 1 to 50 tons.

Uehling Instrument Co., 71 Broadway, New York City. Bulletin 111 describing Uehling Style U carbon dioxide equipment, built in single and multiple units, for serving any number of steam boilers simultaneously up to six. The purpose of the equipment is to save fuel by burning it with the proper air supply.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Bulletin 830, illustrating and describing Cutler-Hammer battery charging equipment for charging all kinds of electric vehicles, including pleasure cars, large and small industrial trucks, mine battery locomotives, ignition and starting batteries on gasoline cars, etc.

Doehler Die-Casting Co., Brooklyn, N. Y. Circulars treating of the properties, characteristics, and applications of white metal alloy die-castings, aluminum die-castings, "Do-Di" finished brass castings; "Do-Lite" babbitt-lined aluminum bearings; and babbitt-lined bronze bearings for internal combustion motors.

Hammond Steel Co., Inc., Syracuse, N. Y. Booklet treating of the characteristics and application of "Status," an oil-hardening tool steel, which is claimed to be non-shrinkable and therefore applicable for use in making cutting tools and delicate dies which must be hardened without change in either size or shape.

Wetmore Reamer Co., Milwaukee, Wis. Bulletin 14, illustrating and describing the details of construction of Wetmore cylinder reaming sets, which consist of a roughing reamer, a semi-finishing reamer, and a floating finishing reamer. Reference is also made to the adaptation of the semi-finishing reamer of the cylinder set for line and pilot reaming.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 421, illustrating and describing the details of construction of Buffalo conoidal fans for heating and ventilating systems. The catalogue gives tables of fan performances by means of which engineers and architects will be able to make fan selections to meet any demands encountered in ordinary heating and ventilating practice.

F. A. Calhoun Co., Jersey City, N. J. Catalogue 5, illustrating and describing portable gas and oil-fired heat-treating furnaces. Specifications are given for high-speed steel furnaces, carbon steel furnaces, cutting tool furnaces, vertical hardening furnaces, lead hardening furnaces, oil tempering furnaces, aluminum melting furnaces, rivet heaters, and forging and bending furnaces, etc.

Norton Co., Worcester, Mass. Circular containing an article on the use and selection of Norton grinding wheels for application on Pratt & Whitney surface grinding machines. The article discusses the factors influencing the action of the grinding wheel, types of wheels to be used for various materials, storage of wheels, mounting, dressing, lubricants, wheel speeds, and table speeds.

OVERCOME YOUR TAPPING TROUBLES BY SPECIFYING

CARD TAPS and DIES

Exact in size, uniform in temper, true to pitch and in every possible way High Grade.

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HAMMACHER, SCHLEMMER & CO.

Hardware, Tools and Factory Supplies.

NEW YORK (Since 1848) **4th Avenue and 13th Street**

Golden Co., 405 Lexington Ave., New York City. Prospectus No. 256, illustrating and describing the Sip machine for setting adjustable snap gages, which is made by the Societe Genevoise d'Instruments de Physique, of Geneva, Switzerland. Circular descriptive of a locating machine, which is made in four sizes, the capacity of the smallest size being 3 by 3 inches, and that of the largest 24 by 32 inches.

Independent Pneumatic Tool Co., Chicago, Ill. Catalogue 11, containing descriptions, illustrations, and tables of specifications for "Thor" pneumatic tools and portable electric drills. Some new additions to the line are presented in this catalogue, consisting of motor-driven air hoists, pneumatic sand rammers, universal vise for pneumatic drills, hose coupling, power screwdriver, hose clamp, and hose mender.

Crescent Belt Fastener Co., 381 Fourth Ave., New York City. Circular 227, entitled "Modern Scientific Methods in Belt Joining," containing a detailed description, illustrated with diagrams and sketches, of the correct method of joining belts with Crescent belt fasteners. The pamphlet gives dimensions for Crescent plates and rivets to be used with belts of different widths, lengths, and thicknesses. Copies will be sent upon request to the machinery service department of the company.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Blanchard Grinder Data Book, containing illustrations, drawings, and production data on fifty different jobs which have been machined on Blanchard surface grinders. The pieces ground range from very small steel parts up to large heavy castings. The book is intended for the use of managers, superintendents, tool engineers, and foremen. It is of convenient pocket size, and contains a large amount of production data which should be of interest to those engaged in this class of work.

Edward R. Ladew Co., Inc., 54 Franklin St., New York City. Pamphlet entitled "A Study of Various Types of Belting," containing an article by Ernest D. Wilson which records the results of an investigation on power transmission by belting conducted by the Mellon Institute of Industrial Research of the University of Pittsburg for the Leather Belting Exchange. The article describes the belt-testing equipment employed, and gives the results of the belt tests that were made on leather, solid woven, balata, friction surface rubber, and stitched canvas belts.

General Electric Co., Schenectady, N. Y. Bulletin 46112, describing the deflection potentiometer, which is intended to cover a field where an accuracy is required between that of the precision potentiometer and the laboratory standard instrument. Bulletin 41021 A, describing the latest design of RF, Form A, direct-current adjustable-speed motors, rated from 2-3 to 50 intermittent horsepower. This motor is said to be particularly suitable for reversing planer operation, pipe threading, tapping, or for driving any machine repeating its cycle of operation.

Hendey Machine Co., Torrington, Conn. Catalogue covering the line of milling machines made by the company, which includes plain and universal types, made with either geared spindle or belt cone drives. The construction of the machines is described in detail, and specifications are given for the different sizes. The various attachments used in connection with these machines are also illustrated and described. One section of the catalogue illustrates the line of machines equipped with motor drive, and shows typical operations performed with these machines.

Geometric Tool Co., New Haven, Conn. Catalogue covering the complete line of screw-cutting tools and machines made by this company, which includes self-opening adjustable screw-cutting dieheads, solid adjustable die-heads, taper threading die-heads, adjustable collapsing taps, combination collapsing taps and reamers, hollow milling tools, chaser grinders, and threading machines. Following the illustration and description of each tool is a table giving complete specifications. Operating instructions are also included. The last section of the catalogue contains tables giving dimensions for standard screw threads.

TRADE NOTES

Republic Tool Products Co. has recently been organized at 300 Troy St., Dayton, Ohio, to do die and stamping work. F. H. Poeppelmeier is president and manager.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., announces that its publicity department was moved August 1 to the Chicago Pneumatic Building at 6 E. 44th St., New York City.

Green Engineering Co., Dayton, Ohio, is now located in its new fireproof building at 725 S. Main St., Dayton. The shop is 50 by 150 feet, and is fully equipped to manufacture automobile parts.

Gustave Wiedeke Co., 1833 Richard St., Dayton, Ohio, manufacturer of railroad and boilermakers' tools, is erecting a three-story brick addition to its plant, 80 by 100 feet, to take care of its increasing business.

Springfield Advance Machine Co. is a new concern organized at East and Harrison Sts., Springfield, Ohio, to engage in general jobbing work and the manufacture of agricultural implements. H. J. Kirchwehm is manager.

Phoenix Mfg. Co., Eau Claire, Wis., has removed its office from Cleveland, Ohio to Chicago, Ill. W. L. Harrison, who has been manager of the Cleveland office for a number of years, will have charge of the Chicago office.

Barkelew Metal Products Co., Dayton, Ohio, is now located in its new plant at E. Richard and Bowen Sts., which is a two-story brick building, 100 by 150 feet. The plant is fully equipped for turning out screw machine products.

Cincinnati Shaper Co., Cincinnati, Ohio, has just completed a new factory building which will make available 30,000 additional square feet of floor space. The program of the company calls for doubling the output in the near future.

Dole Valve Co. announces its removal to 1923 Carroll Ave., Chicago, Ill., where the company has adequate facilities for manufacturing its line of double compression couplings, priming cups, shut-off cocks, packless radiator valves, and brass fittings.

Southwark Foundry & Machine Co., Philadelphia, Pa., announces that it intends to broaden its field by adding to its present line of hydraulic and power machinery a full line of pneumatic and hydro-pneumatic riveters, and foundry molding machines.

Wolf & Fry, 845 Broad St., Newark, N. J., engineers and architects, have opened a consulting engineering office, where they are engaged in engineering, designing and drafting service, the designing of industrial buildings and the planning of factories.

Carl G. Barth & Son, consulting engineers, have opened an office in the Fuller Bldg., 10 S. 18th St., Philadelphia, Pa., where they will continue to specialize in production and costing methods, etc., based on the Taylor system of scientific management.

Dominion Oxygen Co., Ltd., Toronto, Canada, is planning to erect a chain of oxygen plants in Canada for separating oxygen from the atmosphere, and has just completed the first of these plants at Toronto. Sites for additional plants have been secured at Montreal, Winnipeg, and other points.

Lambert Machine & Engineering Co., Cleveland, Ohio, has purchased the entire stock of the **Carroll Foundry & Machine Co.**, Bucyrus, Ohio, and the two companies will be combined with a capitalization of $1,500,000. The Cleveland plant will be moved to Bucyrus, and extensive additions and improvements will be made in the Bucyrus plant.

Air Reduction Sales Co., 120 Broadway, New York City, is planning to have an exhibit at the annual convention of the American Foundrymen's Association at Columbus, Ohio, in October. Demonstrations will be given showing the adaptability of the new "Airco" welding and cutting apparatus and "Airco" oxygen and acetylene for foundry welding and cutting.

Uehling Instrument Co., 71 Broadway, New York City, manufacturer of fuel economy equipment, is now being represented in the New England states by the Smith Engineering & Supply Co., 89 State St., Boston, Mass. S. W. Smith, president of the latter company, was until recently associated with the Uehling Instrument Co. at its New York office.

National Twist Drill & Tool Co., manufacturer of twist drills, reamers, and milling cutters, whose factory is located in Detroit, Mich., has removed its New York office from 30 Church St. to 73 Warren St. This will be the eastern branch of the company, and a complete stock of the various products will be carried at the new location. V. G. Engleman, formerly of Detroit, will have charge of the eastern branch.

Pennsylvania Pump & Compressor Co., Easton, Pa., has opened the following additional sales offices: 788 Potomac Ave., Buffalo, N. Y., J. B. Laird, manager; 232 St. Clair Ave., N. E., Cleveland, Ohio, L. J. Wakefield, agent; 1956 N. Broadway, St. Louis, Mo., Corby Supply Co., agent; 423 5th St., S., Minneapolis, Minn., L. E. Pollard Co., agent; 804 First National Bank Bldg., Omaha, Neb., L. E. Pollard Co., agent.

Standard Reamer & Tool Co., 410-424 Elmwood Ave., Detroit, Mich., has been incorporated by John M. Biles, formerly general manager of the Detroit Reamer & Tool Co., and Torsten A. Gyllsdorff, formerly superintendent of the Detroit Reamer & Tool Co. The new company will manufacture a complete line of standard reamers, cutters, and special tools. The officers are as follows: President, Arthur J. Stock; vice-president, Frank J. Trippensee; treasurer and general manager, John M. Biles; secretary and superintendent, Torsten A. Gyllsdorff.

Austin Machinery Corporation, 30 Church St., New York City, announces the consolidation of the F. C. Austin Machinery Co., Inc., Linderman Steel & Machine Co., F. C. Austin Drainage Excavator Co., Toledo Bridge & Crane Co., Municipal Engineering & Contracting Co., and other large manufacturers of kindred lines with plants at Toledo, Ohio, Muskegon, Mich., Winthrop Harbor, Ill., and Woodstock, Ontario, Canada. The combined capacity of these organizations will be devoted to mass production of earth-moving and concrete-mixing machinery.

Nelson Tool & Machine Co., Inc., manufacturer of small tools and light machinery, has moved from the shop formerly occupied at 253 Norfolk St., Newark, N. J., to 82 Lewellyn Ave., Bloomfield, N. J. The new building is a two-story brick structure having a floor space of 8000 square feet. The company has recently been incorporated under the state laws of Virginia at $100,000 and is provided with greater facilities for handling the manufacture of its product. The executives of the new organization are Otto Nelson, president; J. R. Peters, vice-president; Charles W. Nelson, treasurer; and Alexander W. Nelson, secretary.

Millers Falls Co., 210 River St., Millers Falls, Mass., has purchased the plant of the **West Haven Mfg. Co.**, at West Haven, Conn., which for twenty-five years has been engaged in the manufacture of "Universal" and other brands of hacksaws, band saws and small tools. Not only will the Millers Falls Co. continue the manufacture of "Universal" saws, but it will also make at its West Haven plant a complete line of both hand and power hacksaws under the "Millers Falls" brand. Hereafter the business of the company will be carried on through its plants at Millers Falls, Mass., Brattleboro, Vt., and West Haven, Conn.

Vermont Tap & Die Corporation has just been incorporated in Newport, Vt. The active head, H. E. Paine, has had considerable experience in the manufacture of taps, dies, reamers, twist drills, and milling cutters, having held various positions with Butterfield & Co.—Division of the Union Twist Drill Co.—from draftsman to general manager, which latter position he held just previous to forming the present organization. The officers are as follows: President, P. O. Miller; vice-president and general manager, H. E. Paine; treasurer, B. W. Wilcox. Orders for equipment are being placed, and it is expected that production of machine screw taps will commence about October 1.

Acme Die-Casting Corporation, whose factory and main office are located in the Bush Terminal, Brooklyn, N. Y., has recently opened a branch office in the Machinery Exhibition Sales Department of the Philadelphia Bourse. This office is in charge of Edward McK. Hunt, who will handle the business in New Jersey, eastern Pennsylvania, Maryland, Delaware, and the District of Columbia. Offices are maintained at the present time in Detroit, Cleveland, Chicago, Pittsburg, Rochester, Boston, and Philadelphia, and it is contemplated opening another office in the near future in Newark, N. J. The company specializes in the production of zinc, aluminum, tin, and lead alloy die-castings.

Oxweld Acetylene Co., 640 Frelinghuysen Ave., Newark, N. J., manufacturer of oxy-acetylene welding and cutting apparatus, has established Pacific coast sales and distributing headquarters at 1077 Mission St., San Francisco, Cal. Additional sales representatives' offices are maintained at the following points: Los Angeles, 646 Maple Ave.; Salt Lake City, 908 Kearns Bldg.; Portland, 90 First St.; and Seattle, 433 Pioneer Bldg. Leo Romney is Pacific sales manager, with headquarters at San Francisco. The export department of the company, which was formerly located at the factory in Newark, has been removed to the Carbide and Carbon Building, 30 E. 42nd St., New York City. The department has been reorganized and is now under the direction of R. G. Noble, who will cooperate with the general sales department of the company.

Clark-Mesker Co., Cleveland, Ohio, has been incorporated to take over the machine tool department of the Cleveland Milling Machine Co. The principals of the new organization are D. B. Clark, president, who is also general manager of the Cleveland Planer Co. and the Cleveland Machine Tool Co., and who was superintendent of the Watervliet Arsenal during the war; L. H. Mesker, vice-president and general manager, who was formerly connected with the Motch & Merryweather Machinery Co., Manning, Maxwell & Moore, Inc., Cleveland Milling Machine Co., and Kearney & Trecker Co.; Charles A. Morris, secretary and treasurer. The board of directors consists of T. E. Borton, E. D. Rogers, A. V. Cannon, D. B. Clark, and L. H. Mesker. The company is now manufacturing No. 1 and No. 2 plain and universal milling machines and will soon have a No. 3 machine as well as vertical machines ready for the market.

Ackerman Bros. Co., Inc., 95 Liberty St., New York City, has been appointed direct representative in the New York district for C. E. Johansson, Inc., Poughkeepsie, N. Y., manufacturer of standard gaging sets, precision gage-blocks, snap gages, plug and thread gages, etc. The company has also been appointed representative for the Charles L. Jarvis Co., Gildersleeve, Conn., manufacturer of high-speed tapping devices; B. C. Ames Co., Waltham, Mass., manufacturer of dial indicators and bench lathes; T. R. Almond Mfg. Co., Ashburnham, Mass., manufacturer of micrometers and chucks; the Van Keuren Co., Boston, Mass., manufacturer of optical measuring equipment; Ready Tool Co., Bridgeport, Conn., manufacturer of tool-holders, centers, and lathe tools; Huther Bros. Saw Mfg. Co., Rochester, N. Y., manufacturer of metal slitting saws; and American Saw & Mfg. Co., Springfield, Mass., manufacturer of "Lenox" hacksaw blades.